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AMERICAN

DYESTUFF REPORTER

SEVEN-LEAGUE BOOTS

SEVEN LEAGUE BOOTS have been donned by this nation's dyers and dyestuffs makers since we entered the war. Speed and production became the order of the day. Under the pressure of war we've greatly increased production of Ponsol dyes for military requirements . . . helped develop speedier, more economical methods of application.

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Du Pont Dyestuffs

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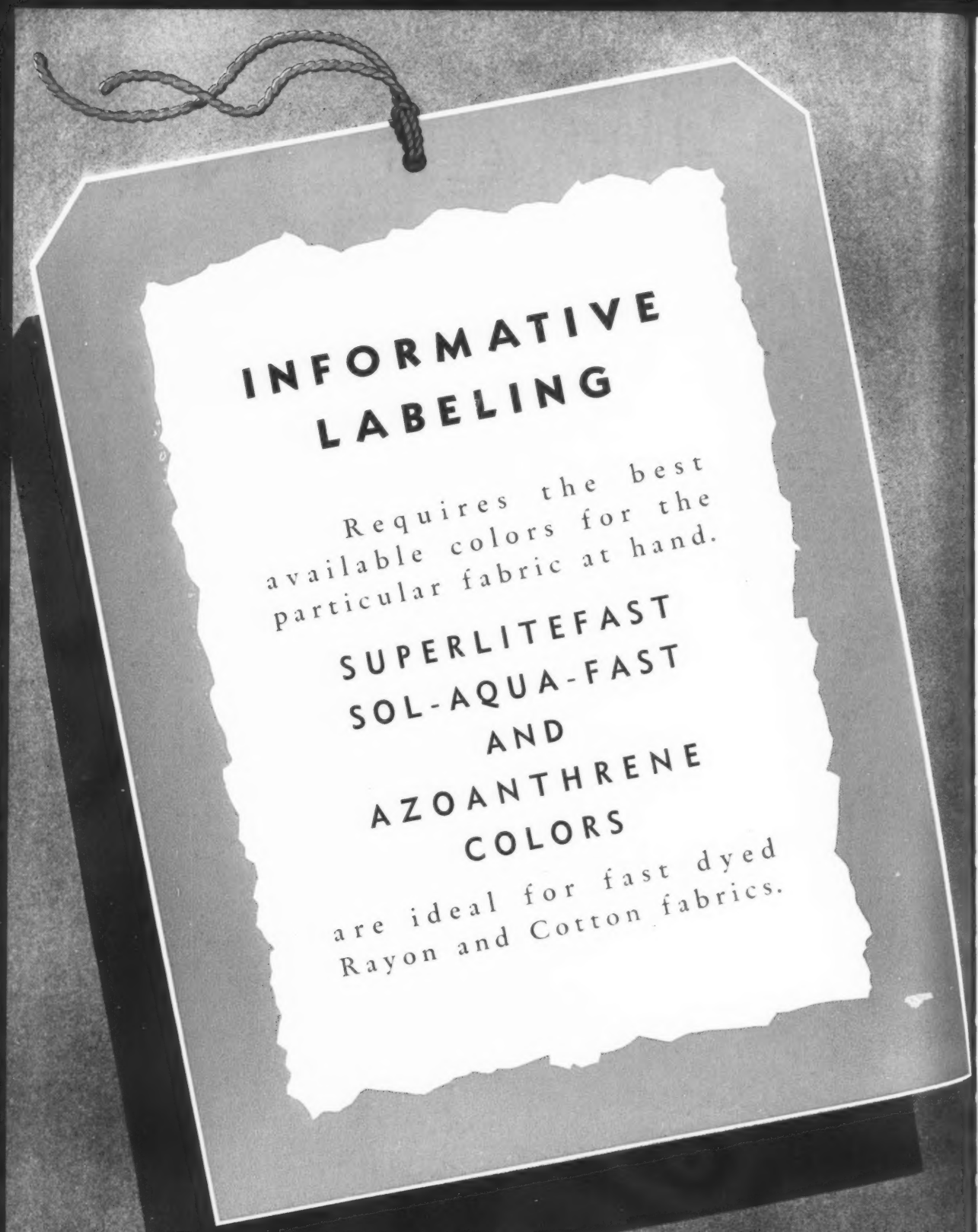

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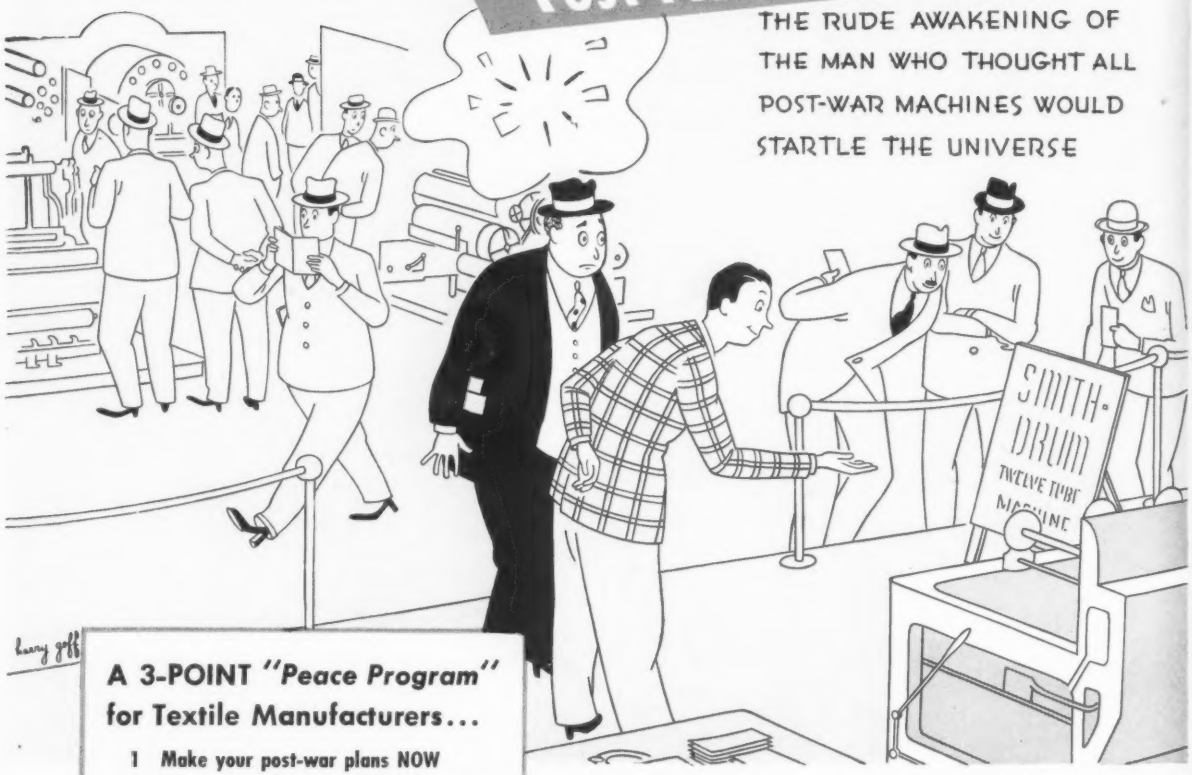
POST-WAR "Post-Mortem" №4

THE RUDE AWAKENING OF THE MAN WHO THOUGHT ALL POST-WAR MACHINES WOULD STARTLE THE UNIVERSE



A 3-POINT *"Peace Program"* for Textile Manufacturers...

1 **Make your post-war plans NOW**
don't let peace catch you without definite plans for products, markets, sales and production.

2 **Decide on new equipment needs NOW**
don't wait until the war is over before making a thorough survey of your production equipment and deciding what machines must be replaced.

3 **Order your new equipment NOW**
don't risk serious delay in securing necessary new equipment for post-war production. Metals and other basic materials will continue to be scarce for a long time after the war ends.

If you are going to need new dyeing and finishing equipment after the war, we earnestly recommend that you place your order with us *now*. Our "Post-War Purchase Plan" assures you prompt delivery when war restrictions are lifted. Write *now* for complete details of this plan.

ARMY E NAVY

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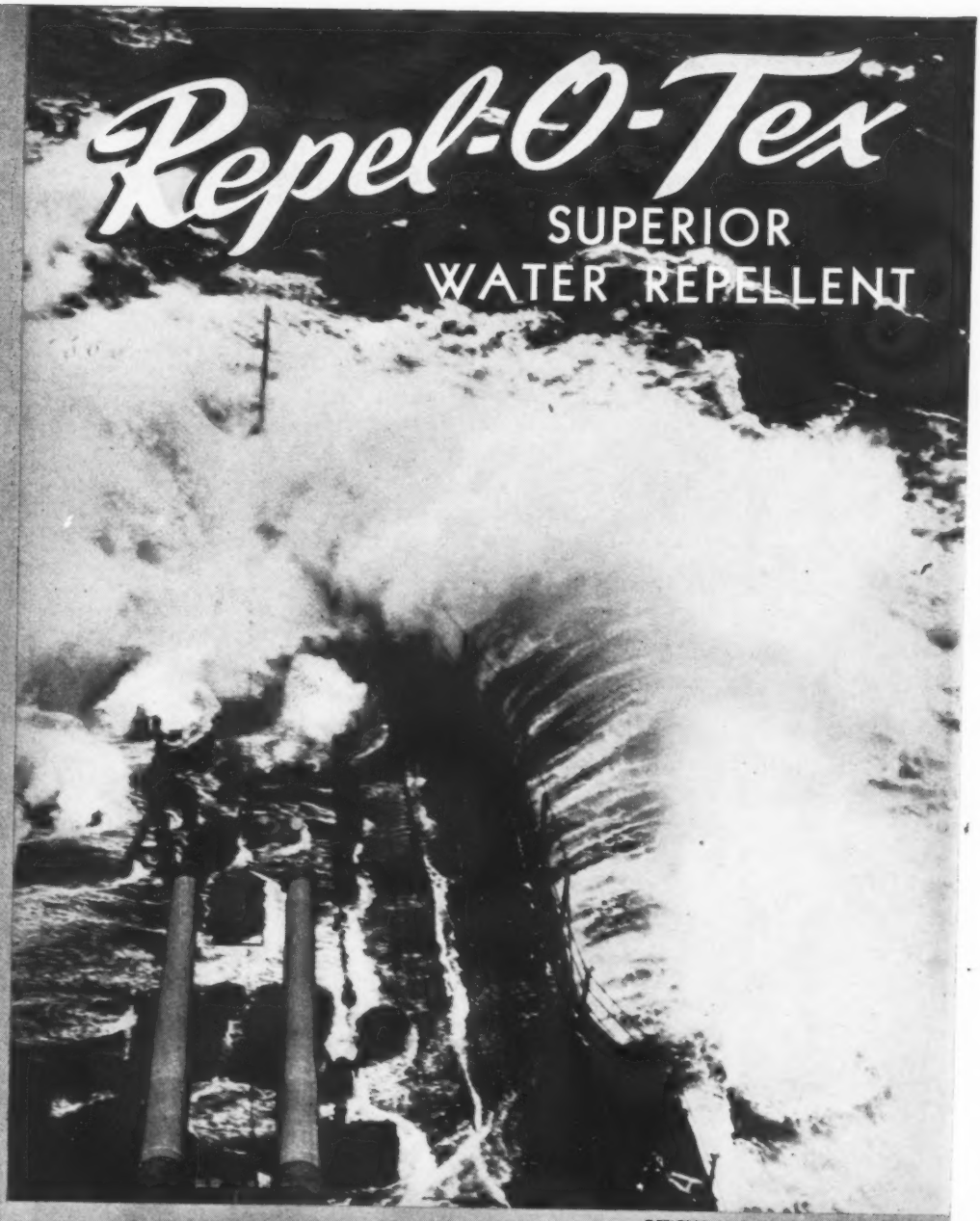

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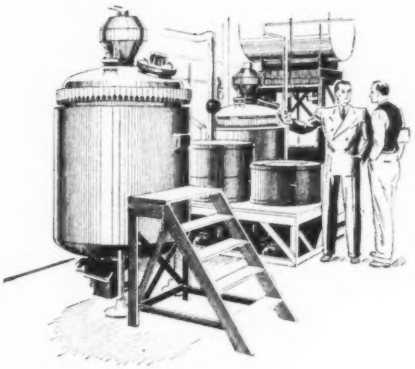

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I can take it. The mess out here. And missing my wife and kid.

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You're working . . . and *I'm fighting* . . . for the same thing. But *you* could lose it for both of us—without thinking. A guy like you could start bidding me right out of the picture tonight. And my wife and kid. There not being as much as everybody'd like to buy—and you having the green stuff. But remember this, brother—everything you buy helps to send prices kiting. Up. UP. AND UP. Till that fat pay envelope can't buy you a square meal.

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I've got your future in my rifle hand, brother. But you've got both of ours, in the inside of that stuffed-up envelope. You and all the other guys that are lookin' at the Main Street shops tonight.

Squeeze that money, brother. It's got blood on it!

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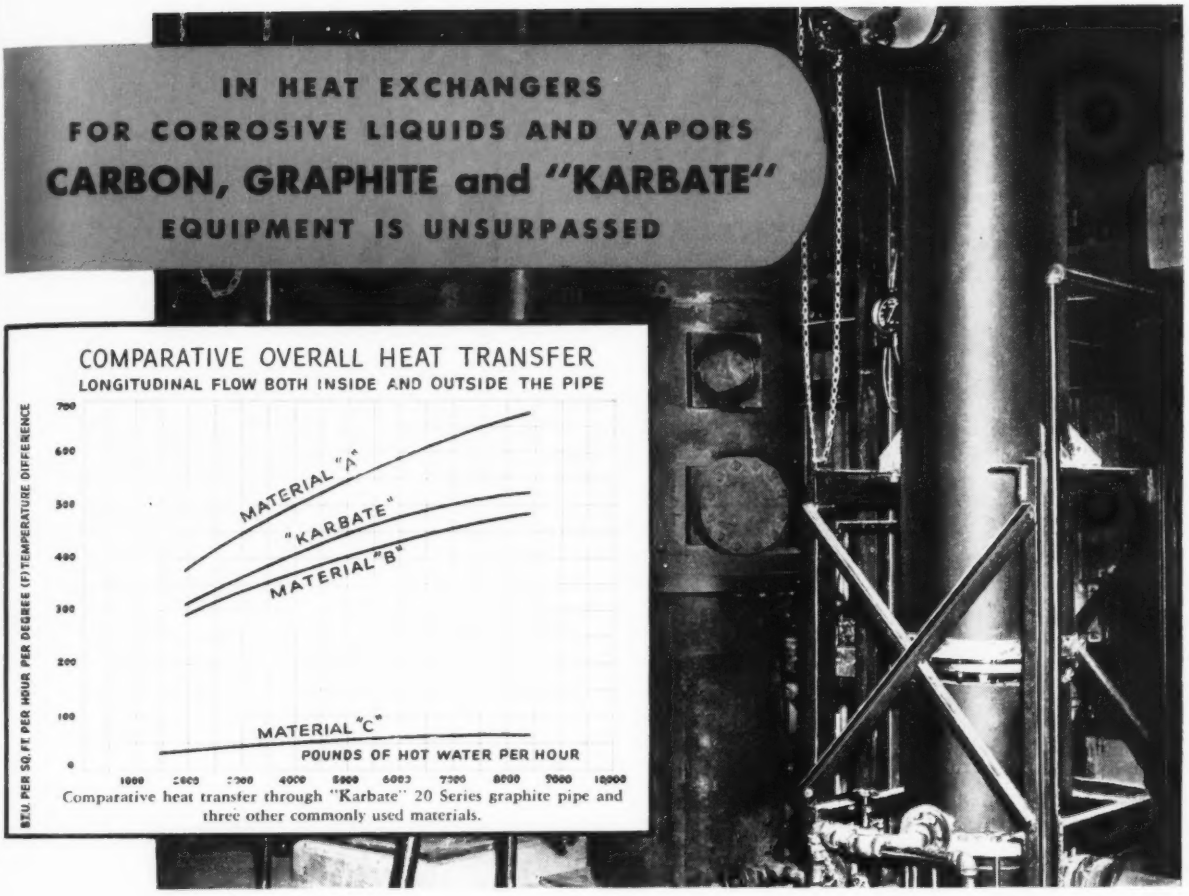

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Material	B.t.u./Sq. Ft./°F./Hr./Ft.	
Copper	224	† 32° F.
Aluminum	75-131	‡ (Room Temp.)
Brass (Red)	93	‡ (Room Temp.)
"Karbate" No. 21, 22 & 28 (Graphite Base)	75	200° F.
Admiralty	65	‡ (Room Temp.)
Tantalum	32	‡ (Room Temp.)
Hi Silicon Cast Iron	31	‡ (Room Temp.)
Steel, 1 Per cent Carbon	26	* 64° F.
Chemical Lead	20	‡ 32-212° F.
Antimony Lead	17-20	‡ 32-212° F.
18-8	7.3-17.0	‡ 32-212° F.
Nickel Chromium (17 Per cent Nickel, 13 Per cent Chromium)	8.5	‡ (Room Temp.)
"Karbate" No. 11, 12 & 18 (Carbon Base)	3	100° F.
Boro Silicate Glass	.63	* 86-167° F.
Chemical Stoneware	.83	‡
Fire Clay Brick	.6-.74	* 932° F.

†International Critical Tables.
*"Heat Transmission"—(McAdams, 1933) p. 314.
‡Chemical & Metallurgical Engineering, Nov. 1938, pp. 633-659.

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PRODUCT	DESCRIPTION	USES	SHIPPING CONTAINERS
Aluminum Chloride, Anhydrous, $AlCl_3$ = 133.3	Grayish white solid.	Catalyst for Friedel-Crafts syntheses to produce dyes.	55-gal. drums containing 500 lbs. 5-gal. pails containing 50 lbs.
Antimony Trichloride, Anhydrous, $SbCl_3$ = 228.1	White crystalline solid.	Catalyst in organic syntheses to produce dyes.	Pails containing 100 lbs.
Benzal Chloride $C_6H_5CHCl_2$ = 161.0	Clear, colorless liquid. Sp Gr 1.280 ± .005	Manufacturer of dyestuff intermediates.	5-gal. carboys containing 50 lbs. 12-gal. carboys containing 120 lbs.
Benzotrichloride $C_6H_5CCl_3$ = 195.5	Clear, colorless liquid. Sp Gr 1.380 ± .005 B P 219–223°C.	Manufacture of dyes.	12-gal. carboys containing 120 lbs.
Benzoyl Chloride C_6H_5COCl = 140.5	Clear, colorless liquid. Sp Gr 1.2187 FrP. −0.9°C Min	Manufacture of synthetic organic chemicals through Friedel-Crafts reactions to produce dyes.	5-gal. carboys containing 50 lbs. 12-gal. carboys containing 110 lbs.
Benzyl Chloride $C_6H_5CH_2Cl$ = 126.5	Clear, colorless to light yellow liquid. Sp Gr 1.1002 B P 177-182°C.	Manufacture dyestuffs and intermediates.	5-gal. carboys containing 50 lbs. 12-gal. carboys containing 110 lbs. 55-gal. drums containing 450 lbs.
Chlor Anisidine $NH_2C_6H_3ClOCH_3$ = 157.5	White crystalline solid. M P 79°C. Min.	Manufacture of dyes.	Fibre drums containing 200 lbs.
2:5 Dichlor Aniline $Cl_2C_6H_3NH_2$ = 162.0	Light brown colored solid. M P 49°C.	Dye intermediates.	Fibre drums containing 225 lbs.
Meta Nitrobenzoyl Chloride $C_6H_4NO_2COCl$ = 185.5	Yellow crystalline solid. M P 31-35°C.	Manufacture dyes.	Aluminum cans containing 75 lbs. Terne plate pails containing 55 lbs. 5-gal. glass-stoppered carboys containing 60 lbs.
Monochlorbenzene C_6H_5Cl = 112.5	Clear, colorless liquid. Sp Gr 1.112 B P 131-132°C.	Manufacture sulfur black and brown dyes and other dyes.	5-gal. cans containing 45 lbs. 55-gal. drums containing 500 lbs.
Monochlortóluene $CH_3C_6H_4Cl$ = 126.5	Clear, colorless liquid. Sp Gr. 1.078 ± .005 B P 158-163°C.	Manufacture of dyes.	5-gal. cans containing 44 lbs. 55-gal. drums containing 450 lbs. 110-gal. drums containing 900 lbs.
Para Nitrobenzoyl Chloride $C_6H_4NO_2COCl$ = 185.5	Yellow crystalline solid. M P 70-71°C.	Manufacture dyes.	5-gal. wide mouth glass bottle containing 37 lbs.
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Thionyl Chloride $SOCl_2$ = 119	Clear, light colored liquid. Sp Gr 1630 ± .005 B P 75-79°C.	Manufacture organic acid chlorides and anhydrides, alkyl chlorides from corresponding alcohols.	5-gal. carboys containing 65 lbs. 55-gal. drums containing 725 lbs.

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FEBRUARY 28, 1944

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AMERICAN
DYESTUFF REPORTER

VOLUME 33 FEBRUARY 28, 1944 NUMBER 5

Relations of DYED FIBER DICHROISM to the Adsorption of Dyestuffs on Pulps*

PAUL R. WILEY[1]

INTRODUCTION

CELLULOSE fibers colored with certain dyes and stains exhibit optical anisotropy in the form of dichroism, or a difference in the ability of a fiber to absorb polarized light depending on the angle between the plane of polarization and the fiber axis. This phenomenon is generally considered to be due to an oriented adsorption of dyestuff particles possessing intrinsic dichroism on an oriented cellulose structure. Several investigators have considered this property in relation to the structure of natural and artificial cellulose fibers, but very little attempt has been made to apply it to the study of the mechanism of dyeing.

It is the purpose of the present work to develop an instrument for the measurement of the dichroism of dyed wood pulp fibers and to use it in studying the factors which affect the orientation of dyestuff particles on fibers with the object of obtaining new information concerning the fundamental nature of the pulp-dyestuff bond.

HISTORICAL REVIEW

The phenomenon of dichroism was first observed by Ambronn[1] in 1888. He discovered that cellulose fibers colored with iodine or Congo red exhibited maximum absorption of light when the plane of vibration of the light was parallel to the axis of the fiber and least when the light vibrated perpendicularly to the fiber axis. It had been shown by Conroy[2] and Kundt[3] and was later confirmed by Zocher[4] that certain dyestuffs possess intrinsic dichroism traceable to the structure of the dyestuffs particle or crystal. It was concluded by Ambronn and Frey[5] that, in order to produce the observed mass dichroism of a large number of dye particles, it would be necessary that an oriented adsorption of the particles on the fiber take place. Later Frey-Wyssling[6] further amplified the same hypothesis.

Having concluded that the magnitude of the dichroism was a measure of the degree of orientation of the cellulose structure, as well as a measure of the extent to which adsorbed dye particles are oriented, several investigators made attempts to develop quantitative expressions for the dichroism. According to the theory of the crystal structure of cellulose deduced from x-ray spectroscopy data, the crystal unit should exhibit biaxial symmetry. This means that there should be three principal indices of refraction and, correspondingly, three absorption coefficients, since the two phenomena are closely related. However, it was found that all fibers which were investigated possessed the same symmetry as an uniaxial crystal, the axis of symmetry in the case of fibers lying parallel to the fiber axis[7]. Frey-Wyssling[6] believed that the third refractive index is numerically almost equal to one of the other two and explains the apparent discrepancy in this way. At any rate, in the development of quantitative expressions for the magnitude of dichroism, the assumption is made by all investigators that the cellulose fiber possesses only one axis of symmetry and that this axis lies parallel to the fiber axis.

Herzog[8] reported the first quantitative work on fiber dichroism and expressed the dichroism very simply as a comparison between the transmittances of dyed fibers when the incident light vibrated first parallel and then perpendicularly to the fiber axis. Preston[9] went into the matter more thoroughly and by the application of Lambert's hypothesis and Beer's law derived an expression for the "dichroic constant." His expression involves a ratio of the optical densities or absorption coefficients for light polarized parallel and perpendicular to the fiber axis. Preston made the claim that this constant is independent of the wavelength of the incident light and only slightly dependent on the depth of dyeing. A discussion of these factors will be given later in the light of data to be presented.

Although the above methods of expression suffice to indicate the degree of orientation, they do not yield directly the percentage orientation of the dye particles. Further work was done by Preston[9] and by Morey[10] in deriving expres-

* A portion of a thesis submitted in partial fulfillment of the requirements of The Institute of Paper Chemistry for the degree of Doctor of Philosophy from Lawrence College, Appleton, Wis., 1941. This work was carried out under the direction of Philip Nolan.

[1] Present address, West Virginia Pulp and Paper Co., Piedmont, West Virginia.

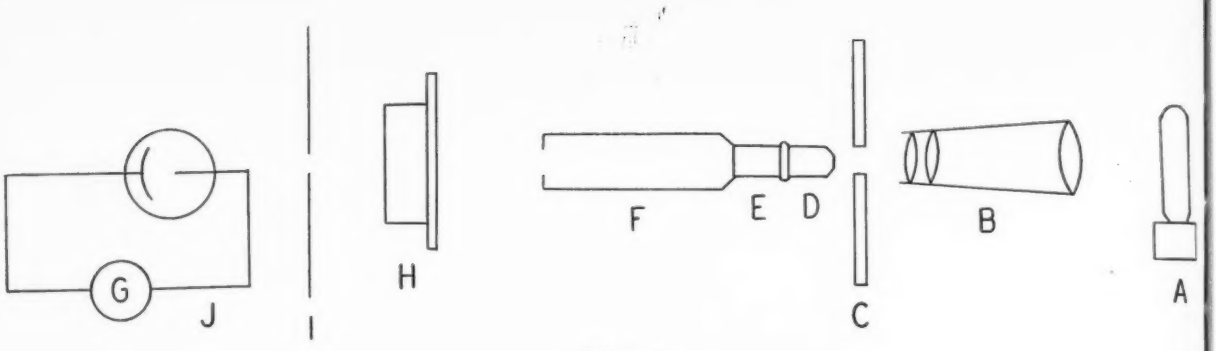

Figure 1
Instrument for Measurement of Fiber Transmittance

A 0-500 μa meter
B Condenser
C Mechanical stage
D 4-mm. objective
E Polarizing prism
F 3X projecting eyepiece
G Type R galvanometer
H Calibrated cross-hair
I Aperture
J Phototube

sions for percentage orientation in terms of transmittances of fibers for light polarized parallel and perpendicular to the fiber axis.

The dichroism of films of dyestuff has been examined by Zocher and Jacoby[11] and by Weigert[12]. The former studied films of dyestuff which had been deposited on glass slides and rendered dichroic by polishing the surface of the film in a given direction. Their expression for the dichroism involved the difference instead of the ratio of the optical densities and required a term to allow for the thickness of the film. Weigert measured the dichroic effect in connection with the photodichroism of photographic films and expressed it as the logarithm of the ratio of the two intensities mentioned by the other workers.

As mentioned in the introduction, the study of the dichroic effect has not been applied to any extent to the mechanism of dyeing. However, there exists in the literature a small amount of evidence indicating that there are observable differences in the orientation of a given dye on a given absorbent, and that such differences may be connected with properties of the dyed material. For instance, it was reported by Schramek and Helm[13] that they had observed two types of dye adsorption on fibers; an oriented adsorption on the fiber surface accompanied by a displacement in the absorption maximum toward higher wavelengths, and an unoriented adsorption within the fiber accompanied by very little displacement in the absorption maximum. Kondo[14] examined dyed collodion and gelatin films with regard to their dichroism and observed that those dyes which bleached through the action of light exhibited dichroism. More work in gelatin films was done by Kemula[15], who studied the effect of dye concentration on dichroism. He reported that concentration had a measurable effect on dichroism and offered an explanation on the basis of two modifications of the dyestuff which were dependent on the concentration.

DESCRIPTION OF INSTRUMENT

For the measurement of fiber transmittances previous workers used projecting microscopes in conjunction with visual comparison photometers. The use of visual comparison photometers, however, has two drawbacks: (*a*) where a large number of measurements is to be made, the procedure is tiring to the eye and necessitates frequent rests which cut down the speed with which a number of observations can be made; (*b*) at very low fiber transmittances it is difficult to make accurate readings by visual comparison because of the low level of the illumination. For these reasons it was decided to attempt the use of a photoelectric cell for the transmittance measurements.

The general layout of the instrument is shown diagrammatically in Figure 1. The light source A is a 120-volt, 200-watt Mazda projection lamp with a tungsten filament. The letters B to F represent the parts of a Bausch and Lomb No. 3024 microprojector. A condenser at B focuses the lamp filament on the slide held on mechanical stage C. A 4-mm. objective at D projects the image of a fiber through the rotating polarizer at E and a 3X projection eyepiece at F to an aperture at I. The diameter of the aperture (about 4-mm.) is small enough so that it may be completely covered by most of the fibers found on the slide if a pulp whose fiber widths are comparable to those of an average spruce woodpulp is used. The fiber image is admitted through the aperture to the surface of a phototube. At H is located a rotating cross-hair calibrated from 0 to 360 degrees. Its mounting is hinged so that it may be swung in and out of the light beam at will. The polarizer at E is calibrated also from 0 to 360 degrees with a scale which can be read with an accuracy of two degrees. To determine the cross-hair setting which would represent the plane of polarization for each setting of the polarizer, an analyzer was temporarily mounted in the beam between the eyepiece and the cross hair. (Inasmuch as there are two definitions of "plane of polarization" it is hereby specified that the plane of polarization will be considered as parallel to the plane of vibration or electric vector of the light beam.) For a given cross-hair setting the image of one side of the analyzer prism was lined up with one of the hairs and the polarizer turned to the point of extinction. This procedure was repeated for every 10-degree interval throughout the whole scale and a table showing the polarizer settings which corresponded to every cross-hair setting was constructed. In this way, when a

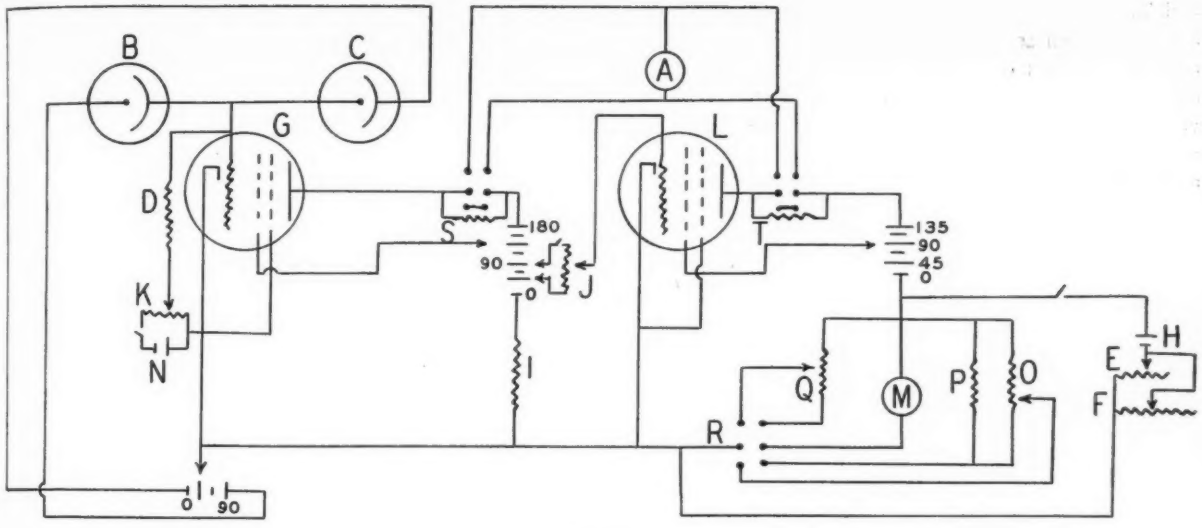

Figure 2
Design of Two-Stage Amplifier

A	0-500 μ a meter	H	Dry cells, 3 volts	O	0-10,000 ohm resistor
B	Phototube	I	100,000-ohm resistor	P	900-ohm resistor
C	Phototube	J	0-10,000 ohm resistor	Q	0-50,000 ohm resistor
D	150-megohm resistor	K	0-400 ohm resistor	R	Double throw switch
E	0-2000 ohm resistor	L	No. 77 vacuum tube	E	500-ohm resistor
F	0-50,000 ohm resistor	M	Galvanometer or meter	T	16-ohm resistor
G	No. 77 vacuum tube	N	"C" battery, 7.5 volts		

First tube plate current—300 μa
Second tube plate current—150 μa
Filament supply—6 volts

dyed fiber is brought into the field, the plane of polarization can be brought parallel or perpendicular to it by lining it up with the cross hair, reading the corresponding polarizer setting from the table, and setting the polarizer at this reading. The cross-hair mounting can then be swung out of the beam and the transmittance readings taken.

The photocurrent of the emissive type phototube employed was amplified by means of a direct current amplifier. After experimentation with a single-stage amplifier a two-stage amplifier whose design is indicated in Figure 2 was found to be satisfactory. Its operation is in principle as follows: The effective photocurrent from the active and dummy PJ-22 phototubes at B and C in passing through the 150-megohm grid resistor at D controls the grid potential of the first No. 77 amplifier tube G. The active and dummy tubes view the same light source and are connected so that they buck each other and approximately balance out any fluctuations in intensity of the light source. A second No. 77 amplifier tube is connected so that its grid bias is controlled by changes in the plate current of the first tube passing through the 100,000 ohm grid resistor at I. It was necessary to insert proper bias potentials in the grid circuits of both tubes to provide for operation of the tubes within their linear ranges. The bias for the first tube is obtained from a 7.5-volt "C" battery at N, whereas the second tube bias is tapped from the first tube plate supply. Variable resistors at K (0 to 400 ohms) and J (0 to 1,000 ohms) permit adjustment of the fixed bias to each tube. The changes in plate current of the second tube occasioned by variations in the light intensity falling on the photocell are measured by the sensitive meter at M. This meter could be either a Weston Model 440 galvanometer or a 0 to 50 microampere meter, depending on the sensitivity required. In order to use the galvanometer it was necessary to insert a variable resistor (0 to 10,000 ohms) at O to enable control of the sensitivity. At the same time a fixed resistance of 900 ohms was inserted at P to provide a combined shunting resistance of about 800 ohms around the galvanometer, which resulted in approximate critical damping. It was also necessary, however, to insert a 0 to 500,000-ohm variable resistor at Q for control of the meter sensitivity when the microammeter was being used at position M. These resistors were connected as shown through a double-pole double-throw switch R so that either could be thrown in the circuit, depending on whether the galvanometer or the microammeter was being used at M. In order to maintain the plate current of the second tube at the level necessary for operation of the tube in its linear range (from 2 to 4 milliamperes) and yet prevent too much current from passing through the sensitive meter or galvanometer at M, it was necessary to use a compensating current through M which opposes the plate current. The compensating current is supplied by two 1.5-volt dry cells at H. Coarse and fine adjustment of the compensating current is accomplished by means of the 0 to 2,000 and 0 to 50,000-ohm variable resistors at F and H. The plate current for either tube can be measured by the 0 to 500-microampere meter at A. Resistors of 500 and 16-ohms located at S

and T, respectively, change the meter sensitivity in such a way that full scale deflection could be obtained for the maximum values of plate current attained in either circuit. The ranges of linearity in the plate current-grid voltage relation were then found to be roughly between scale readings of 50 and 250 for the second tube and 200 and 400 for the first tube. The currents were always adjusted to 300 for the first tube and 150 for the second tube and were kept within one scale division of these values throughout.

Satisfactory operation was obtained with this instrument using the tungsten source and the Wratten monochromatic filters in conjunction with a Jena BG-18 infrared-stopping filter. The Weston Model 440 galvanometer was used at position M under these conditions. For investigations involving the measurement of large numbers of fibers it was found best to use an H-3 mercury arc source furnishing an intense green line (isolated with Wratten filter No. 77 and a Jena BG-18) at 546 mmu. Under these conditions the 0 to 50-microampere meter could be used at M, thereby enabling very rapid reading of the photocurrent.

The linearity of response of the instrument to changes in intensity of the light falling on the photocell was checked both at the low level of illumination obtained through the use of the tungsten source and the Wratten monochromatic filters and at the higher level obtained when the mercury arc was used. A GM Visitron phototube was substituted for the PJ-22 when the low level of illumination was being used. The transmittance of a screen was then determined both on the instrument and on the General Electric recording spectrophotometer. The values were within 0.5 per cent of the value obtained with the spectrophotometer over the visible spectrum (64.0 per cent), and varied between 63.0 and 64.3 per cent over the spectrum when the instrument was used in conjunction with the Wratten filters.

At the high level of illumination furnished by the green line of the mercury arc at 546 mmu, the linearity was checked with three different screens of widely different transmittances. Both PJ-22 and RCA 918 phototubes were used. The following transmittances were obtained:

	Transmittances		
Screen	*PJ-22*	*RCA*	*Spectrophotometer*
	%	%	%
A	66.5	65.7	65.7
B	46.2	45.5	46.5
C	28.0	27.8	27.0

It was concluded from these figures that the linearity of response was satisfactory.

The completed instrument is shown in Figure 3.

GENERAL PROCEDURES

Method of Measuring Fiber Transmittances

The image of the fiber whose transmittance was to be measured was focused on the calibrated cross hair, keeping the filter holder and filters out of the beam. The cross hair was lined up parallel to the fiber axis and a reading taken from its scale. The fiber was then moved out of the field, the filters were moved into the beam, and the

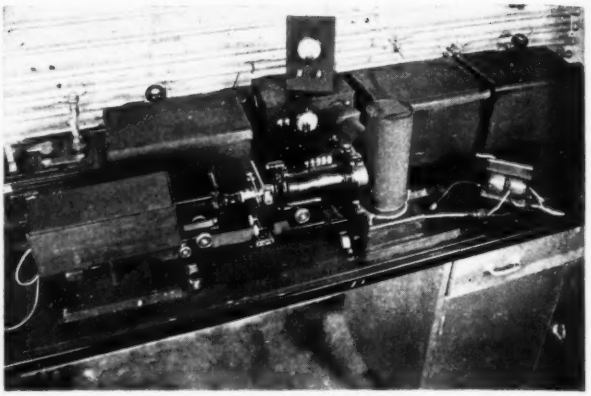

Figure 3
Photograph of Completed Instrument

top of the photocell box was closed. From the table relating cross-hair settings with polarizer settings, the position of the polarizer which would bring the plane of polarization parallel to the fiber axis was determined and the polarizer was turned to this position. The appropriate meter was switched in and, with the light stopped off, the needle was set at zero, by adjusting the compensating current. The light stop was removed and a reading taken on the meter. The fiber was then moved into the field to cover the photocell aperture and a second reading made. Leaving the fiber in that position, the polarizer was turned to bring the plane of polarization perpendicular to the fiber axis and the third reading taken. The fiber was then removed from the field and the final meter reading observed. The ratio of the meter readings with the fiber in and out of the field for any given setting of the polarizer represents the transmittance at that angle of polarization.

General Procedure Used in Dyeing

The dyeings were all carried out in a two-liter beaker containing about 1,500 cc. of dye solutions of such concentration that the amount of dye adsorbed by the pulp present had an insignificant effect on the dye concentration in the bath. The pulp samples were suspended in the bath in small baskets, about 3 x 3 x 9 cm. in size, made of 35-mesh wire screen. The baskets were fastened to metal supports so that they could be inserted into or removed from the bath simultaneously. The tops of the baskets were always allowed to protrude above the surface of the bath so that the pulp samples were kept separate from each other.

The dye bath was heated to the desired temperature before putting in the pulp samples. The pulp samples (about 0.2 gram in each case) were disintegrated and transferred to the baskets, which were lowered into the bath and each sample was stirred. Samples of about 0.05 gram of pulp were removed at intervals from each basket to furnish several different depths of dyeing for each pulp. The dyed samples were placed in 100 cc. of distilled water and stirred. They were then filtered on a Büchner funnel and washed with an additional 100 cc. of water.

(Continued on Page 110)

PROCEEDINGS OF THE

American Association of Textile Chemists and Colorists

FEBRUARY 28, 1944

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CALENDAR OF COMING EVENTS

Meeting, Rhode Island Section, Providence Engineering Society, 195 Angell St., Providence, R. I., March 31, 1944. Speaker: Duncan G. Carmichael, Aralac, Inc., "Dyeing of Aralac."

Meeting, Philadelphia Section, Engineers Club of Philadelphia, 1317 Spruce Street, Philadelphia, Pa., March 10, 1944. Speaker: William A. Wolhar, Rosemary Manufacturing Co., Roanoke Rapids, N. C., "Screen Printing," supplemented by motion pictures. Note change in date and place.

Twentieth Anniversary Meeting, Piedmont Section, Poinsett Hotel, Greenville, S. C., March 25, 1944.

Meeting, Council, New York City, April 21, 1944.

Meeting, New York Section, Downtown A. C., 19 West St., New York City, April 21, 1944.

Meeting, Research Committee, New York City, April 22, 1944.

THE "CROWN" TESTED PLAN

ARTHUR R. WACHTER
American Viscose Corp.

IT IS NOT necessary to repeat here, the Aladdin-like growth of rayon—the test-tube baby—which grew from a shiny, weak, stiff horse-hair-like material some twenty-five years ago, to its present soft, strong filaments and rayon staple fiber cut to mechanical exactness. This advance of a synthetic fiber over the natural fibers we now take as a matter of course, although it is really both physically and chemically one of the outstanding advances of the twentieth century.

Rayon is a scientifically controlled product. It is manufactured with laboratory precision to provide accurate and mechanical control at all times.

As long ago as 1930, the American Viscose Corporation came to realize that they should regard the finished rayon fabric as well as the greige goods and the yarn. The same scientific control which gives rayon uniformity in its properties also provides for its versatility. Strength and extensibilities can likewise be controlled as well as dyeing properties. To do this it was necessary to institute tests in an effort to provide for particular consumer protection and continued consumer satisfaction.

The Quality Control Plan which was at that time begun, applied specifically to knit underwear, because our production was going principally to the knitting trade. With the cooperation of the U. S. Bureau of Standards, size specifications were established. The Better Fabrics Testing Bureau, and our Textile Development Unit at Marcus Hook, Pennsylvania, worked together to establish quality control standards to include proper count of both courses and wales as well as strength of fabric, colorfastness to washing, shrinkage in laundering, etc. This plan, operated for four years and had a definite stabilizing influence through the retail, manufacturing and knitting trade.

In 1934 many woven fabrics started to be submitted for testing under the Plan. As woven fabrics became part of the Quality Control Plan and as activities progressed it was necessary to expand our laboratory facilities and to employ talent with knowledge of dyestuffs, finishes, proper constructions, testing methods and gear these to operation on a practical basis, and to maintain quality on a level to assure consumer serviceability. This "Crown" Tested program was certainly instrumental in the stabilization of constructions and influenced the trend to trade "up" rather than "down" on dyeing and finishing quality.

In September of 1942 the American Viscose Corporation announced the introduction of its new "Crown" Tested Plan, under which new Minimum Requirements were established for rayon fabrics for men's wear, women's wear and home furnishings, paying especial attention to the particular use to which the fabric will be put, rather than receiving just a general all purpose series of tests.

Several interesting and important reasons influenced the bringing out of the new Plan.

I. To cooperate with the war effort by establishing a set of standards designed to conserve raw materials, manpower, and factory equipment which might otherwise be wasted in the manufacture of rayon fabrics and apparel of inferior quality.

II. To meet effectively the rising public demand for durable merchandise and honest value by providing stabilized fabrics regardless of price range.

III. To simplify labeling, not only for the information of the ultimate consumer, but also for the mutual benefit of converters, finishers, manufacturers and retailers as well.

IV. To help the industry in the development and marketing of new serviceable rayon fabrics to replace those no longer available under wartime conditions.

V. To protect and maintain the public good-will now enjoyed by numerous reliable manufacturers and merchants and the American Viscose Corporation as a rayon producer, both during and after the current cycle of a wartime seller's market.

The fundamental purpose of the "Crown" Tested Plan is to provide an added incentive for the production of serviceable fabrics containing "Crown" Rayon yarns and staple fibers. It is therefore of direct interest to every branch of the trade whose merchandise is sold on a basis of practical serviceability.

Under the Plan, fabrics by licensees of American Viscose Corporation, containing our Company's "Crown" Rayon may be submitted for fabric stability tests including fabric strength, seam slippage, dimensional restorability, colorfastness, permanence of finish and other qualities where required. Samples of every color of every dye lot are so tested. Minimum Test Requirements have been established by American Viscose Corporation, and are placed at levels which the Corporation believes will assure good fabric performance. These tests are generally conducted in accordance with U. S. Department of Commerce, National Bureau of Standards' Commercial Standard CS59-41 unless otherwise indicated in the Minimum Requirements.

The Minimum Requirements that have been set up are based on research and are determined upon, in a large measure, with specific reference to the use for which the

*Presented at meeting of Rhode Island Section, November 26, 1943.

particular type of fabric is manufactured. For example, the Minimum Requirement for fabrics to be used in men's sportswear are in many respects different from Minimum Requirements for fabrics to be used in women's underwear.

Fabrics which pass the tests become eligible to carry identification as "Crown" Tested, which will be indicated to the consumer by the presence of a "Crown" Tested tag or label. Every effort has been made to make the new "Crown' Tested tags or labels truly informative and helpful to retailers and customers alike, as well as in accordance with the best procedures recommended by government agencies and consumer and retail groups. The information given is factual and specific, and is worded so that guesswork as to the nature, quality and predicted performance of the fabric is eliminated. Through every branch of the trade and finally to the consumer, these fabrics and products made from them may be identified as "Crown" Tested. It should be pointed out, however, that the "Crown" Tested insignia applies only to the fabric, never to the tailoring, workmanship, etc., involved in the complete product.

The "Crown" Tested Plan furnishes a constructive program for tying in with the rising trend toward informative labeling and advertising. As a "Crown" Tested Rayon fabric passes successively from converter to manufacturer to retailer to consumer, the identification serves as a *witness* constantly testifying to the fabric quality. Each branch of the trade may use it as a means to keep quality at a high level to assure salability and good fabric performances. Thus the Plan provides an added incentive to improve fabric stability and thereby minimize tendencies to sacrifice sound fabric qualities for temporary competitive advantage. The result is a form of consumer performance which can benefit every licensee.

Complete details of the "Crown" Tested Plan are contained in our "Crown" Tested Licensee Handbook. In the Handbook, we divided our Minimum Requirements into three fabric groups—Men's Wear—Women's Wear—Home Furnishings. Each of these fabric groups is again divided into end useage classifications. For example, in the Men's Wear group we have our Minimum Requirement No. 1—set up for Stability of Men's Woven Sportswear Fabrics for use in Slack, Trouser and Jacket. Minimum Requirement No. 1A—is set up for the Stability of Men's Woven Sportswear Fabrics for use in Sport Shirts. No. 1B is set up for Stability for Men's Knitted Sportswear Fabrics for use in Sports Shirts. No. 2 is set up for Stability of Men's Woven Suiting Fabrics, and so on, covering each use to which a Men's Wear Rayon Fabric may be put. The same principal is carried out in the Women's Wear group and also in the Home Furnishings group.

Each Minimum Requirement specifies the tests which the fabric must meet to carry identification as "Crown" Tested. A few general comments may be of interest to indicate the nature of the various tests. For example: for colorfastness to laundering, the laundering tests for "Washable" Rayon fabrics is conducted at 160° F.; while the test for "Hand Washable" Rayon fabrics is conducted at 105°F. "Dry Cleanable" Rayon fabrics must undergo tests for both the wet and dry procedures. For colorfastness to sunlight, Sportswear and Suiting Fabrics are given Test No. 3 of Commercial Standards CS59-41, which requires 40-hours Fade-Ometer exposure. Women's Rayon Dress Fabric, if they are to be labeled "Washable" are required to withstand 40-hours Fade-Ometer exposure, and if labeled "Hand Washable" they must withstand 10-hours Fade-Ometer exposure under standard conditions. All "Crown" Tested Rayon fabrics containing an acetate rayon must pass the A.A.T.C.C. Test for atmospheric gas fading. Another interesting point is that all "Crown" Tested Rayon fabrics are to be so constructed and so finished that they can be restored to within 2% of their original dimensions by normal pressing and shaping methods. This factor is determined by a tension pressing method of testing which was originated by the U. S. Testing Company and developed by interested parties in the industry. Test figures indicate consistent results and an accurate prediction as to actual garment performance, and it is, in our opinion, the best method available to determine this factor.

All rayon fabrics that are submitted whether for men's wear or women's wear are tested for hot pressing, wet pressing and crocking.

In addition to these tests, each fabric submitted is tested for permanence of finish. If a fabric is to be labeled as "Washable," we make three consecutive tests according to U. S. Quartermaster Corps P.Q.D. 38. If it is to be labeled as "Hand Washable" it receives this same test and fabrics that are labeled as "Dry Cleanable" receive three consecutive tests in accordance with the CS59-41, Section VI Dry and Wet Procedures. This we find to be a very important and necessary test procedure because if, after laundering, hand washing or dry cleaning the finish which has been applied to a fabric is removed the consumer has an altered character in the fabric and the garment no longer possesses the characteristics which influenced its purchase. When a fabric changes noticeably in hand or character after these tests, we reserve the right to withhold approval.

In our labeling picture, we have employed the colors of the traffic light system. We use the "green light" to indicate a washable fabric; we use the "amber light" to indicate hand washable; and the "red" to indicate a dry cleanable fabric. The "green" means: "go ahead and wash it—either at home or in a commercial laundry." The "amber" means: "caution" and the handling instructions advise the consumer that it must be laundered in a temperature not in excess of 105°F.; the "red" means: "stop"—this garment can only be dry cleaned. The "green," "amber," and "red" discs are not to be construed as a means of grading the quality of a rayon fabric.

It is not necessary nor practical to process all rayon fabrics to meet the "green light" or "Washable" requirement of 160°F. Considering the end use to which a fabric may be put, and considering also the construction of certain fabrics, a "Hand-Washable" requirement may serve the consumer much more readily than were the fabric processed to withstand 160° F. This extra over-building of fastness properties may only add to the cost of the finished garment and not serve any additional usefulness. For example: the "amber light" or "Hand Washable" requirement is certainly sufficient for fabrics that are to be used in women's under-garments and many other products. Again, a fabric that bears the "red" or "Dry Cleanable" label is not necessarily inferior in quality to either the "amber" or "green light" because the garment may never be required to be "Hand Washed" or "Laundered." Each of our requirements were designed to give satisfactory consumer performance for a particular type of fabric used in a particular type of garment.

Considering the comparative newness of the "Crown" Tested Plan we are gratified with the progress and the acceptance by converters, finishers, manufacturers and retailers and the Plan is daily gaining impetus. This is, in a large measure, due to the interest and the cooperation which the finishing and the dyestuff industry has given our Plan.

As previously stated, the "Crown" Tested Licensee Handbook is descriptive of our entire Plan, how it operates; how quality-minded converters and finishers may participate in this progressive movement. This Handbook is available upon request from the American Viscose Corporation.

This Handbook is in loose-leaf form because from time to time as progress permits, some, or it's possible that all, of these requirements will be changed and for this reason it is necessary that we know exactly where each Handbook is—we must keep an accurate mailing list in order to keep you up-to-date of changes in the Plan.

DISCUSSION

Q. How do you determine the amount of finish which is lost—you have certain definite standards for the durability of the finish—how do you determine how much is lost in one washing, two washings, three washings, etc.?

A. We say if a fabric changes appreciably in character we reserve the right to withhold our approval. If we feel that there is such a change that the consumer would be dissatisfied because she had no longer the character that influenced the purchase, then we would have to withhold approval. When the consumer restores a fabric after refreshing, I believe that the average consumer tries particularly hard to restore the original character. If we cannot do this in our laboratory, we do withhold approval and no label is then issued.

Q. Mr. Wachter, your label is a tag?

A. We have both tags and booklet forms. I have with me a few of these copies of the booklet which really describe the tag. We have the "green light"—"washable"; the "amber light"—"hand-washable"; and the "red light"—dry clean only. We have the handling instructions next. In dry cleaning instructions we say merely just be sure your dry cleaner knows the percentage of acetate and so forth. Then we do include the physical tests we make: resistance to washing, perspiration test; crocking test; sunlight; atmospheric fading; and so forth. On the last page, we share our responsibility. The wording is: "A 'Crown' Tested fabric by .....,—fabric approved for a certain use—'Crown' Tested Minimum Requirements number. . . ."

Q. Strictly from a consumer's point of view—a garment is purchased with a label which might create an impression at the time of purchase. The garment becomes worn. What happens to it to the consumer's knowledge? From then on he might give it to a laundress or something. Could you get a label woven or printed and sewn into the garment, so that it would be of lasting value?

A. We do issue woven garment labels; but they aren't particularly popular because it costs a quarter of a cent a garment to sew it in. I think we have an educational job to do with the cutting trade. We are also designing now a label which can be used as a hanger. We are also working with the American Institute of Laundering on a fellowship; and we would like to have them use a label where a formula for laundering will be used in the laundering—a code formula made up by us. We are working also with the Pennsylvania State Cleaners & Dyers Association to include a label that a certain formula is to be used in the dry cleaning; that also will be coded.

Q. They will be permanent labels?

A. Yes, that is a permanent record that it is "Crown" Tested, and a permanent record for both laundries and dry cleaners.

Q. I would like to ask about the testing of these samples. If there should be a landslide towards these testings, how long is it going to take you to test these samples? Deliveries are important these days.

A. Forty-eight hours after we receive the sample the finisher and the converter have their reports.

Q. How do you know that it is your particular type of rayon?

A. We do know: We have a contract number from the converter. From that contract number we find out from the greige mill just what yarn we issued for that. Then in our Standards Division at Marcus Hook we also test the fabric for yarn content.

Q. A chain is no stronger than its weakest link . . .

A. Oh, we have quite a few weak links!

Q. But I didn't mean you. . . . My point is this: If nine shades out of ten meet your requirements, how about the one shade in the ten which doesn't?

A. It is not included in our "Crown" Tested plan. We will label nine out of ten if the nine are good; but if the tenth doesn't come up to our standards we do not issue our label for the tenth. We make our tests wherever possible with CS59-41 where appreciable change is defined. If this is found to be present, we have to withhold approval on the fabric.

Q. In regard to establishing the test of 160° F. for rayon, isn't that rather high?

A. No, all commercial laundries operate between 145° F. and 150° F. and you need the 10° F. of tolerance. Sometimes commercial laundries might exceed 150° F. When we say "washable," we do realize that requires a Vat-dyed job; and that is exactly what it should be.

Q. Don't you think it is sort of inviting disaster encouraging housewives to boil up their rayons and so forth when the publicity so far has been to keep the temperature down?

A. We have quite an educational job to do; but we think that with the job we are doing with the consumer it will be all right. Rayon is a good fabric—it doesn't have to be pampered. Right now we are talking about color fastness; and we say "do not wash in a temperature in excess of 160° F.," and if the consumer doesn't know what 160° F. is, it is our job to educate the consumer to know. Our advertising this year is directed thus as an educational project.

Q. Reading from your booklet, "The 'Crown' Tested plan applies only to the fabric; contrasting trims should be washed separately." . . . How many garments are made with a trim which can be detached?

A. They should be if they aren't. The National Association of Cutters has a rule that trim should be removable on all garments.

Q. Did I understand you to say, Mr. Wachter, that the "Crown" Tested plan for fastness would absolutely preclude any other colors than Vats?

A. Well, for fastness—we personally don't care—if they meet the 160° F. test, you can use anything you like. If you can find a vegetable dye which will meet these tests, go ahead and use it; but it must meet the reuirements. We do not dictate—we only try to help.

Q. I should think a great many developed colors would stand up to a 160° F. test.

A. In active wear you would have a sunlight requirement of forty hours' Fade-Ometer test; and though you might have the 160° F. fastness, it wouldn't have the light fastness.

Q. Are you cooperating with the dyestuff manufacturers in developing dyes?

A. No—they are cooperating with us! We maintain a dyestuff research laboratory in New York; and the dyestuff manufacturers realize that we can help them, and, inasmuch as our plan is favorably accepted, they want to work with us to give their customers the type of dyestuffs and materials which will meet our requirements.

Q. Does your organization work this plan out to the extent that you recommend dyestuffs?

A. We dare not and will not recommend. We can't, because we can't solicit business for any one dyestuff organization.

Q. In recent years there has been an increasing use of rayon in the worsted industry; and I am wondering if the "Crown" Tested plan is so set up to include fabrics constructed of worsted and rayon combinations.

A. Yes, sir, it is. In order to be considered a rayon fabric, it must, however, contain fifty per cent or more of rayon to be "Crown" Tested. If it meets our requirements, then it is eligible to carry the label as "Crown" Tested.

Q. According to the back of the booklet, do you exclude the protein fibers?

A. We will, of course, include silk . . .

Q. No, I mean how about Aralac?

A. Not yet. Not that we have anything against it; but we don't know much of anything about it. Naturally, we can't include it in our program until we know more about it.

If it really is the good fabric we think it is, it certainly will be included in the "Crown" Tested plan; but not yet, for we haven't enough facts available. As soon as we do and we know that it is a good fiber, we will include it and will be happy to do so.

Q. You said that the maximum shrinkage loss is two per cent?

A. No, Dimensional Restorability. "Shrinkage" is understood to mean a dimensional *change* that takes place in a fabric when it is wet or cleaned; and usually that change is considered permanent. With a properly constructed and finished rayon fabric, that dimensional change is not permanent, for you may launder a rayon fabric and have as high as four per cent dimensional change. But the fabric will be restored to less than two per cent with pressing.

Q. I was just going to ask how your "traffic lights" would work in a case that we had occasion to work with a few years ago. Spun rayon plaid dress goods for a time were very good; they were made here in the East and vat colors were used in the dyeing. The fabric was sold at a profit for the mills and was very acceptable in the trade. As the fabric got popular in the trade, some of the other mills took it up, cut the construction of the fabric, and instead of using vat colors they used direct colors; and very soon that fabric lost its popularity in the trade. How would the "traffic lights" and "Crown" Tested plan work in a case like that?

A. It would depend on the original advertising. When it was originally introduced, it would have been introduced

as a "green-light" fabric—vat dyed, properly constructed. Somebody began to prostitute that fabric; one would be labeled with a "green light" and the other wouldn't be so labeled. It wouldn't be labeled at all—in a factual way—for no one would say "this is good-for-nothing!" If we did our job, the consumer would know that the "Crown" Tested washable fabric is the one she must buy. A consumer only has to be burned once!

Q. There is one other point: I recall being in a print works where a garment was returned; and, after considerable difficulty, it was traced and it appeared that the garment had been washed—in this case, according to the claim, accidentally by the consumer or the laundry. In the "Crown" Tested procedure, how is that handled? The customer definitely was at fault.

A. Well, we hope that consumers read labels. We are now making a survey to find out whether or not they do. That's why we use the colors of the traffic lights, because everyone understands them. If they make a mistake, we certainly can't assume any responsibility for their mistakes. We do, with each label, have handling instructions for the care of the fabric. We still have some work to do in educating the consumer as to what our labels really mean; but it is not difficult to get the idea across to the consumer because we think we have something that all understand in the colors of the traffic lights, and they won't make mistakes.

Q. You would assume the responsibility in a case like the one we were discussing before?

A. We don't guarantee. We merely say that our tests *predict* that the fabric will be satisfactory.

Q. Do you test every dye lot?

A. Every color of every dye lot is tested.

Q. Doesn't that get to be quite a job?

A. We have three laboratories; and we really hope it will get to be a tremendous job!

Q. Don't you find that most hand-washing is hung out in the sunlight?

A. No, most of it is hung in bathrooms—stockings, panties, slips. If they are to be hung outside, we do say "hang away from direct sunlight or heat."

Q. How do you differentiate on print runs?

A. We test each combination and also each ground shade in a print lot.

Q. You mean you strike off from each shade?

A. Yes, that's right.

Q. Then the print works would have to send in a collected series of samples to be so identified?

A. No, the converter sends the samples in.

Q. Mr. Wachter, you say you are embarking on a program of educating the public: What is going to happen when the public *all* asks for "Crown" Tested fabric? (I have nothing to do with rayon in my own business, by the way!)

A. Well, we don't mean to corner the market. We *are*, however, the largest producers.

Q. What type of color would you use on fabrics to be *sure* to have the "green light"?

A. Well, vats. . . .

Q. Could you tell us about the "VATRU-SET" used by North Carolina Finishing Co.?

A. No, I am sorry, we can't. We can't reveal to anyone how that works. We would like to work with any finisher on a program such as this, however.

Q. I believe last year we had Mr. Clarke, who talked on the dyeing of viscose and rayon fabrics regarding the application of vat colors to rayons. I was wondering if you could tell us in what way some of the faster of the vat colors could be applied to viscose and then meet the "Crown" Tested plan.

A. There is a large print works, and there are many other plants which are generally doing this today.

Q. Mr. Wachter, in getting approval what is the minimum and maximum size of the lot?

A. It may be 100 yards; it may be 500,000 yards.

Q. 500,000 yards might be dyed in a good many batches.

A. We require a submit then from each batch. We have to depend on the finisher-licensee for using the same formula and so forth. No matter where we may find the garment, we can trace it back to the original order form. We have a dozen girls all over the country buying goods in stores. We can trace these back to the cutter and the converter and the finisher. That is the only policing effort we make.

Q. On filament rayon—do you think this will enter the field of the "green light"?

A. Yes, definitely.

Q. What do you think of vats on filaments?

A. There are many types of fabrics containing filament warp that are now vat dyed, such as Fugi's and Luana's. These are, of course, a filament viscose warp with a spun filling. Until the development of equipment which will allow fabrics to be handled on a continuous vat dyeing unit without tension, an all filament cloth is not as yet a practical one for vat dyeing.

I understand that several of our textile machinery people are working on equipment of this kind. This would have to be a unit so constructed that the fabric is completely immersed in the reducing liquor without tension of any kind.

I have seen some blueprints of this type of planned equipment and believe that soon after peace these machines will become a reality.

Q. Mr. Wachter, you spoke about the test being developed from the standpoint of the use to which the fabric is to be put. I have in mind a mill which has developed a high-grade drapery line which is sold for dry cleaning but has 140 hours light fastness, which, of course, is a primary selling point.

A. We just place a floor on our requirements—not a ceiling. We require the floor. Our floor is the forty-hour test.

ONE HUNDRED AND THIRTY-SEVENTH MEETING OF THE RESEARCH COMMITTEE

THE Research Committee held its 137th meeting at the Chemists' Club in New York City on January 22, 1944. Present were Chairman Louis A. Olney presiding, W. D. Appel, A. G. Ashcroft, K. H. Barnard, E. C. Bertolet, J. R. Bonnar, R. G. Buck, W. H. Cady, H. Christison, H. D. Clayton, J. L. Crist, M. A. Dahlen, J. N. Dalton, C. W. Dorn, E. Driscoll, O. G. Edwards, A. R. Fletcher, A. C. Goodings, T. Goulet, H. M. Hartnett, S. L. Hayes, A. E. Hirst, H. V. King, W. Klaas, D. P. Knowland, E. D. Lind, L. S. Little, O. F. Marks, J. F. McCoy, J. E. Meili, W. R. Moorhouse, G. A. Moran, A. D. Nute, W. F. Prien, F. A. Prisley, M. D. Reeser, B. A. Ryberg, C. H. A. Schmitt, C. A. Seibert, G. A. Slowinske, T. R. Smith, R. H. Souther, H. W. Stiegler, R. S. Stribling, H. B. Sturtevant, F. R. Tripp, B. Verity, P. J. Wood, H. L. Young and H. C. Chapin, Secretary.

The Chairman gave a general report on the activities of the Committee and its sub-committees. Mr. Bonnar summed up replies received from a recent questionnaire on development of the research program. Mr. Little presented the report which on the preceding day had led the Council to appoint an Executive Committee on Research with himself as Chairman. The Research Committee voted its approval. Mr. Wood emphasized the salient features of this report and outlined the present status of Corporate membership contributions necessary for development of the new program. Mr. Appel defined its scope as first to improve test methods, including any on the margin of our field of textile chemistry which are not receiving adequate attention from other organizations. With regard to research fellowships Dr. Olney said these would be confined to projects involving general information to the industry rather than relative values of competing manufactured products.

Mr. Marks, reporting for the Committee on Shrinkage of Fabrics Composed of Manufactured Organic Fibers, emphasized the partial regain in dimensions of shrunken rayon or acetate crepe, necessitating a special test for shrinkage, more complicated than that applied to cotton fabrics. The performance of a new machine for this purpose is now being studied under the American Viscose Scholarship at the Lowell Textile Institute.

Before weaving blends of dyed wool into the new light fastness standards for distribution, Mr. Christison asked time to make fading tests on knittings from these blends. The spectrophotometer had checked visual comparisons of fading in the experimental standards. The dyes had proved stable under washing and under ordinary artificial illumination.

Mr. Slowinske recommended that the present water spray test be adopted as an official standard method, stating that in accordance with it about 500 testing outfits are now in use. He recommended the immersion test also for official adoption, after certain modifications. The hydrostatic pressure test he said required further study, particularly in comparison with other tests in view to reconciling differences. Another test, which he termed "dynamic" he said is needed to simulate the effect of a driving rain.

Thomas R. Smith, reporting for the Committee on Ageing of Sulfur Dyed Textiles, recommended accelerated ageing tests in an oven or steam ager, which were adopted as tentative standard methods. R. H. Souther succeeded him as Chairman of this Committee. Mr. Barnard discussed the prospects of work by various agencies, under government auspices, on the general problem of the deterioration of cotton through age and exposure. Mr. Moran reported progress in adapting the Crockmeter to scrubbing tests. Having at last secured materials for the new test fabric of wool, cotton, viscose, bemberg, acetate and nylon, the manufacturers gave some hope of deliveries by March.

Respectfully submitted,
HAROLD C. CHAPIN, *Secretary*

REPORT OF SUB-COMMITTEE ON WASH FASTNESS TESTS FOR DYED OR PRINTED COTTON

AT THE present time the committee is endeavoring to establish a test that will definitely indicate the effects of friction or rubbing on dyed or printed cotton materials. The color on such fabrics is frequently affected either by rubbing between the hands with soap and water to remove stains, or by friction in a laundry wheel. In such cases the cloth rubbing upon itself because of the pressure on a wash board, or friction due to agitation in a home washer tends to rub off the surface color and thus seriously reduces the shade and in some cases causes surface rub or crease marks which give an objectionable appearance to goods so washed. The effects of washing are due mainly to the action of water, soap, alkali and friction. Water, soap and alkali affect mainly soluble dyestuffs by dissolving out the dye and staining other fabrics washed at the same time, especially trimmings which may be insoluble and not much affected by soap or alkali. Neither should they be removed by mechanical action.

Insoluble colors are primarily pigments when fixed on or in the fiber, they may be deposited inside the fibers in which case they are fast, or on the outside of the fibers or threads in which case they are liable to rub off under friction. All colorings are likely to be in part on the surface of the fabric and liable to rub off. Poorly processed vats may be to a considerable extent on the surface but are sure to be in part dyed into the fiber. The

surface color may be reduced by hard soaping in the finishing plant before shipping or in the No. 3 washfastness test, or in the first two or three launderings but what remains is dyed into the fiber and is not further reduced by 30 or more repeated launderings. Light and medium shades of naphthols show similar characteristics. Pigments do not ordinarily penetrate or dye the fibers; they are mainly on the surface and held there by a fixing agent. How well they are held depends on the quality of the fixing agent and how completely they are cured. The pigment colors are usually unaffected by water, soap or alkali, so if well cured they pass the No. 2 and No. 3 standard wash fastness test. Friction or rubbing produces effects depending on how well the processing has been done. Well processed pigments resist one or two launderings or a No. 3 wash fastness test better than do vats or naphthols which usually show certain effects from the action of soap usually becoming brighter, redder, yellower, bluer, sometimes stronger, enough so as to be appreciable; but not objectionable. After twenty or thirty repeated launderings the vats and usually the naphthols still appear very good. Well processed pigments lose very little on first laundering but lose as much on each subsequent laundering, so that after 10 or 15 launderings they may show noticeable loss; and after 30 launderings they show serious loss; on the other hand poorly processed pigments will show poor fastness to five launderings. As these different classes of colorings vary so in their fastness characteristics, it is deemed, by the committee, necessary to set up a test that will indicate the particular fastness property above mentioned which may be referred to as a friction, rub or abrasion test, or by some other suitable designation.

The No. 3 test is to remain unaltered as it indicates the effect of water, soap, alkali and staining action on other fabrics; while the friction test will indicate what happens when the material is subjected to energetic friction or rubbing action with soap and water.

For the purpose of the test a modified crockmeter is being utilized. The sample, wet out in standard soap solution, is so attached to the moving arm of the crockmeter that it will rub upon itself as many strokes as found suitable to show desired results. In the case of a coloring loose to rubbing an appreciable removal of surface color will occur while fast colors should not rub off. Several of these modified crockmeters are being prepared for distribution among committee members for checking with each other on results of tests.

It was found impossible to increase the severity of the No. 3 test without the likelihood of a number of dyeings being rated as below No. 3 standard, which actually have been found satisfactory to consumer use in standing many repeated launderings. This fact was established only after conducting 5-10-15 and 30 launderings at several commercial power launderies on a wide range of fabrics, dyed shades and prints, with all types of colorings some well processed and some poorly processed. Similar fabrics were subjected to home laundering in an ABC electric home washer, for comparison.

GEORGE A. MORAN, *Chairman.*

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MEETING, RHODE ISLAND SECTION

ON January 28th at 8:00 p.m. the Rhode Island Section held its monthly meeting at the Providence Engineering Society hall. Dr. Anthony M. Schwartz, Research Director at Alrose Chemical Co., was the speaker and his subject, "Substantivity and Its Role in Textile Processing," outlined the factors and forces that interplay in the application of dyes and other materials on cellulose fibers to get colored and finishing effects.

Kenneth C. Everett, chemist at Powdrell & Alexander made some remarks on "What the A.A.T.C.C. Means to Us."

The Report of the Executive Committee on Research was read by the Secretary and Mr. King, our Chairman, made it the occasion for an appeal to all members to get more Corporate Memberships, starting with the company with which they are employed. The meeting of 75 persons adjourned at 10:15 p.m.

Respectfully submitted.

ROBERT W. JOERGER, *Secretary.*

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20th ANNIVERSARY MEETING, PIEDMONT SECTION

THE Piedmont Section will honor charter members and past chairmen at the 20th Anniversary Meeting, Greenville, South Carolina, March 25th. Plans are being completed for this meeting and it is hoped that all the original members and past chairmen of the Piedmont Section will be present on this auspicious occasion.

We are anxious to hear from the following, stating whether they can be present. We are taking this means of contacting these members because many of the addresses have been lost.

If your name is listed below and you have not indicated your intentions of being present, please notify the Publicity Chairman as early as possible so that adequate preparations can be made. If any one reading this notice can give me information regarding those names listed below please be kind enough to advise. If your name is on this list and you cannot be present, perhaps you will write us a letter, letting us hear from you so that we can report that all members "are present or accounted for."

Harry W. Ormand	J. H. Carey
E. H. Killheffer	P. F. O'Neill
V. D. Le Pottier	N. Vieira
H. S. Busby	J. W. Estlow
Kenneth MacKenzie	J. F. MacIntyre
J. G. Stott, Jr.	H. S. Siever
Brown Mahon	G. F. Luck
G. H. Dubois	J. Baynard Smith
G. I. Purvis	H. M. Chase
A. G. Tew	K. W. Franke
W. D. Shields	Hugh J. Horne
P. L. Sullivan	C. H. Stone

A. R. Thompson, Jr.

If you know of any members that were present at the inaugural meeting and whose names are not listed above, please notify A. R. Thompson, Jr., P. O. Box 1988, Charlotte 1, North Carolina.

A. R. THOMPSON, Jr.
Publicity Chairman

OBITUARY

JAMES H. MacMAHON

JAMES H. MacMAHON, 83, pioneer in introducing the use of American-made bleaching powder and, later, liquid chlorine, in paper pulp bleaching, died at his home in Buffalo, N. Y., on February 7. He was intimately connected with the early development of chemical manufacturing in the United States, was widely known in the paper and other chemical-consuming industries, and for nearly 40 years was connected with The Mathieson Alkali Works.

Mr. MacMahon was born in New York City in 1860, but spent most of his early life in England, first in Liverpool and later in Widnes, the English alkali manufacturing center, where he received a valuable chemical education. His career in industry began with the position of chemist at the DeSota Chemical Works at Widnes, where he eventually became works manager. He later held a similar position with the Cheshire Alkali Company, which operated an ammonia-soda plant at Middlewich, Cheshire.

In 1897 Mr. MacMahon returned to the United States and became associated with the Castner Electrolytic Alkali Company, a subsidiary of The Mathieson Alkali Works. The company was then completing the installation of an electrolytic plant at Niagara Falls and Mr. MacMahon was given the responsibility of standardizing the manufacturing operations in connection with this pioneer venture.

At that time the chlorine produced in the electrolytic cells was used in the manufacture of bleaching powder, the first to be made commercially in this country. Practically all of the bleach used in the United States had previously been imported from England and considerable pioneer work had to be done to convince users that the new domestic product was superior to the imported material. Besides carrying on his managerial duties, Mr. MacMahon played an active part in gaining acceptance for the American-made bleach. Some years later, with the development of facilities for the liquifying of chlorine gas and for its safe transportation in liquid form, Mr. MacMahon was active in the field, particularly among the paper mills, in assisting consumers in the conversion from bleaching powder to liquid chlorine.

In 1918, Mr. MacMahon was made manager of the Mathieson plant at Saltville, Va., where soda ash, caustic soda and bicarbonate of soda are produced by the ammonia-soda process. He held this post until 1921, when he was made Technical Representative of the company with headquarters at Niagara Falls, and was placed in charge of development work. He remained with the company in this capacity until his retirement from active service in 1935.

• TEXTARID 918

L. Sonneborn Sons, Inc., 88 Lexington Ave., New York 16, N. Y., has announced an entirely new type of Textarid water repellent known as Textarid 918. It is claimed that this product invariably imparts a 100 per cent spray rating on all acetate taffeta weaves which are normally quite difficult to process successfully from the standpoint of water repellency. It is further claimed that the product imparts a soft, full, mellow hand without impairing the tensile strength. Textarid 918 is easily applied and, it is stated, has been made practically fool-proof. It is already in successful use in some of the leading finishing plants and a number of brand-name acetate fabrics are being processed with it.

• DCAT BANQUET

The 19th Annual Dinner sponsored by the Drug, Chemical and Allied Trades Section of the New York Board of Trade will be held on Thursday, March 9th, at The Waldorf-Astoria. Plans are under way to pay tribute on this occasion to the drug and chemical industry for its outstanding contribution to the war effort and the military and public health of the Allied Nations.

The Reception Committee under the Chairmanship of Guy L. Marsters, Vice President, The Norwich Pharmacal Company, held its organization meeting on Thursday, February 3rd, at 5 P.M. in the Jansen Suite of The Waldorf-Astoria. E. T. T. Williams, Chairman of the Executive Committee of Becton, Dickinson & Company and Chairman of the Section, spoke a few words of welcome to those assembled. John J. Tooby, Manager of Distribution, E. R. Squibb & Sons, outlined the proposed speaking program.

Advance reservations have been so great that all indications are that this year's dinner will be the most outstanding event of its kind ever held.

The price of tickets is $12.50 each, and the dress, as in the past, will be "black tie." Reservations are being received by the Acting Secretary, Miss Helen L. Booth, 41 Park Row, New York City.

• SOLDIERS' SOCKS MUST BE PRE-SHRUNK

In the interest of comfort for the millions of American soldiers now wearing GI socks, the Quartermaster Corps has announced that all socks delivered henceforth will be pre-shrunk.

Extensive field tests have shown that the pre-shrunk variety of GI wool socks (the only kind the soldiers are supposed to wear with GI shoes) wear substantially longer, and are more comfortable, according to the War Department.

The decision was made known to an advisory group from the hosiery industry at a meeting in the Office of The Quartermaster General, on January 26, 1944, when results of the tests were outlined.

More than 10,000 pairs of socks were tested exhaustively by the Quartermaster Corps to determine the relative wearing qualities of socks made according to various specifications to indicate the effectiveness of different yarns, types of construction, methods of reinforcing and pre-shrinking treatments. Shrinkage of wool or part-wool socks was definitely established by these tests to be a primary cause of rapid wear. Identical socks from which shrinking tendencies had been removed were shown to have up to 40% longer wearing life than untreated socks.

The recent change in the grade of wool required in specifications for light weight wool socks and cushion sole socks has made an outstanding contribution toward controlling shrinkage, according to Quartermaster Corps officers. Preliminary results indicate that this change from "not coarser than 60s" grade of wool, U. S. Standard, to "not coarser than 56s" and "not finer than 60s" has reduced shrinkage by at least one third.

• CHEMICALS BY GLYCO

The new 144 page catalogue "Chemicals by Glyco" of the Glyco Products Co., Inc., Brooklyn, N. Y., has just been released. Considerable additions have been made including a number of plasticizers for synthetic rubber, synthetic resins, etc., as well as further information on the esters manufactured by the Company. The usual features have been retained and the manual is complete with formulae, suggestions and tables of useful chemical and physical data. All chemists, technical workers and executives in the Chemical industry are invited to write to the Glyco Products Co., Inc. 26 Court St., Brooklyn 2, N. Y. for a free copy.

• GEIGY RELEASES

Geigy Co., Inc., 89 Barclay Street, New York 8, N. Y., has recently released pamphlets describing the following products:

Artificial Silk Blue R S Conc.—a new

direct blue which produces shades of bright blue with a reddish cast on cotton and viscose rayons. It is stated that it is particularly adaptable for obtaining excellent, level dyeing results when applied to the various rayon fabrics usually dyed on the jig. Pamphlet No. 63M.

Erio Chrome Khaki G L Extra—this dyestuff is said to possess excellent fastness to most all the processes of wet finishing, including carbonizing. It is stated that it is rated very highly for its excellent resistance to light and for producing shades that are little affected when examined in artificial light—the slight change which does take place is to the green tone which, in most instances, should prove advantageous. The dyestuff is useful for obtaining not only self shades but also mode shades in combination with some of the other well known fast to light chrome colors. Pamphlet No. 66M.

Copies of the pamphlets are available upon request to Geigy.

● C.A.A.T.C.C. MEETINGS

The Ontario Section of the Canadian Association of Textile Chemists and Colorists will hold its annual business meeting on March 4th at Hamilton, Ont. Surgeon-Captain Best will be the guest speaker.

The Quebec Section of the C.A.T.C.C. will hold its annual meeting on March 18th in Montreal.

● RAYON GLOSSARY

A "Rayon Glossary" designed to provide a broader and more accurate knowledge of rayon fabrics and terms used in connection with rayon, has just been issued by the American Viscose Corporation and is currently being distributed to textile mills, converters and finishers, and others in the textile industries.

This is believed to be the first comprehensive glossary of this description devoted entirely to rayon and rayon fabrics. The booklet, which contains 64 pages, is divided into two sections. The first contains an alphabetical list of 99 rayon and blended fabrics, with a brief description of each. In most cases the type of weave is mentioned and the major uses for the fabric are indicated. This is followed by a list of definitions of terms used in connection with rayon and the weaving, knitting, dyeing and finishing of fabrics.

The second section of the booklet describes briefly with the aid of flow charts the manufacture of viscose, acetate and cuprammonium rayon, illustrates the difference between rayon yarn and rayon staple fiber, and describes the basic weaves and methods of knitting used in creating fabrics.

The glossary is intended to be of value as a permanent reference work and copies will be distributed not only to members of the textile trades and industries, but also to librarians, schools and colleges, retail stores, home economics teachers, women's clubs and interested government officials.

● NATIONAL STARCH EXPANSION

In line with pre-war plans for the expansion of their Eastern manufacturing facilities, National Starch Products has announced the purchase of the old Wheeler family property adjoining their factory site on West Front Street, Dunellen, N. J.

This acquisition, coupled with National's recent purchase of a substantial plot from the Standard Oil Co., as well as a parcel formerly occupied by the Plainfield Brass Foundry, rounds out the ownership of a tract of some 200,000 square feet which straddles the Dunellen-Plainfield township line.

No new construction is contemplated at this time, as the company is devoting its full energy to the job of obtaining maximum production from existing facilities, so as to meet the heavy demands of government agencies and war industries for their products.

Prior to its purchase, the five buildings on the Standard Oil property had been leased by National for warehouse purposes and it is understood that for the time being, the space will continue to be used for storage.

As already reported, National's New York executive offices and general laboratories recently moved to larger quarters at 270 Madison Avenue. Therefore, this latest announcement clearly indicates that the organization is looking toward the post-war period with full confidence.

● JOINS GOOD HOUSEKEEPING

Herbert R. Mayes, Editor of Good Housekeeping, announces the appointment of Dr. W. E. Coughlin as Textile Technologist in charge of Good Housekeeping's Textile Laboratory, effective February 7, 1944.

Dr. Coughlin, who took his B.S. and M.S. degrees at the University of New Hampshire and his Ph.D. at Penn State College, was formerly with the Celanese Corporation of America where he has been in the technical division since April 1930.

He has been loaned by Celanese at various times to the National Association of Dyers and Cleaners as a Research Associate and has been active both in research and educational work in the textile field generally.

Dr. Coughlin is widely known among retail groups,—appearing before National Conventions of the NRDGA, the Metro-

Affiliated Photo—Conway

Dr. W. E. Coughlin

politan Piece Goods Association and buying groups. In addition, he has travelled widely, working with department store educational departments as an adviser on the sale and care of rayons. His research of fabric damage on all types of wearing apparel and household goods has been widely used and has resulted in frequent requests for addresses before Adjustment Manager groups in many of the large cities.

As Director of Education of the Celanese Corporation, he appeared before home economists and chemists in various colleges throughout the country and at Home Economics Conventions. In addition, he has written many articles on textiles for journals in the various fields of textile and allied industries.

Over the years he has also worked closely with both the men's and women's clothing industries and with garment manufacturers in both fields.

In addition to his extensive experiences with rayon, Dr. Coughlin has done private industrial research on fulling problems with wool and throwing problems on silk.

● MOVE NEW YORK OFFICE

Pennsylvania Salt Manufacturing Co. have announced the removal of their New York office on February 1st to 40 West 40th Street, New York 18, N. Y. The phone number is PEnnsylvania 6-2977. F. G. Rodenburgh and C. A. McCloskey are district sales managers.

● NORANE

Ernest Nathan, president of Warwick Chemical Company, West Warwick, Rhode Island, announces that the company has received a registration of the name "Norane" for their new durable repellent, formerly known as "Warcopel."

● SAFETY RECORD

National Starch Products gave testimony to the splendid safety record of their Dunellen plant employes at a dinner at the Park Hotel in Plainfield, N. J.

Ten departments were awarded safety banners for a perfect record during 1943 by the company president, Frank Greenwall, and the entire staff was highly recommended for its 84 per cent overall reduction in man-hour losses through accidents.

This remarkable record is said to result chiefly from activities of the employees' Safety Committee which, with the co-operation of management, conducts educational programs in the factory, makes plant surveys leading to the elimination of hazards, and adopts safety devices for the workers.

• APPOINTED PHILADELPHIA MANAGER

The National Adhesives Division of National Starch Products has announced the appointment of S. S. Snyder as manager of its Philadelphia Division with headquarters at 1305 Germantown Avenue.

Mr. Snyder has been with National for the entire twenty-five years of his business career, and had been acting as assistant to the late Milton J. Heim in the management of the affairs of the Philadelphia territory. His activities have extended over seven middle Atlantic states, and have brought him prominence in the many markets served by National.

• RETURNS TO CUBA

Alfred Brandt

Alfred Brandt, technical representative for Onyx Oil & Chemical Co. in Cuba, Mexico, Jamaica, Colombia and Venezuela, returned to his headquarters in Havana on February 28th following his semi-annual visit to the Onyx plant in Jersey City.

Give . . .

RED CROSS

1944 WAR FUND

• JOINS HERCULES POWDER COMPANY

Robert A. Lemieux has recently joined the technical sales staff of the Hercules Powder Company of Wilmington, Delaware, manufacturers of chemicals used in many textile processes. Mr. Lemieux is a graduate of Lowell Textile Institute where he undertook the study of Textile Chemistry and Dyeing. He received his B.T.C. degree in June 1938.

Robert A. Lemieux

From 1939 to 1943 he was associated with the technical sales force of Penick & Ford, Ltd., Inc., of New York City. In his technical work with Hercules Powder, Mr. Lemieux will concentrate on the introduction of Hercules products for the textile industry and will cover the Southwestern part of New England.

• OPEN FORUM •

Question

58. We are dyeing yarn on perforated tubes, which we call pressure dyeing. Consequently, the dye bath is much more concentrated than its former procedure, namely in skeins.

As a result, on heavy shades we get some sort of a coagulation after dyeing the yarn, and when this yarn is placed on a spool and passed on to the cutting-up trade, the tailors find difficulty in unwinding this thread, as it creates some sort of an electrolytic effect, thus retarding the passage of the thread through the eye of the needle.

Can you help us towards eliminating this problem? Thank you for your cooperation.—**B.S.**

Answers

Answer No. 5—I doubt very much if your dyeing problem can be blamed on your pressure machine or any other kind of dyeing machine. I used to experience the same trouble on sewing machines and chenille cutting machines.

I found that metallic soaps or metallic compounds precipitating from the dye bath or soaping bath form on thread or yarn, causing a sticky or unnatural feel to the thread. For example, any type of cloth waterproofed with a metallic compound will stick to any surface or burn a needle on a sewing machine within one minute, creating an electrolytic effect.

The following formula will eliminate your difficulty: for every hundred gallons of dye bath or soap bath, use four ounces of tetra sodium pyro phosphate.

Robert K. Remer

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NOTE

If readers of the Reporter wish to communicate directly with those who answer open forum questions, and will advise us, we will be pleased to make the necessary contact. Write to Dr. L. A. Olney, Directing Editor, Lowell Textile Institute. Lowell, Massachusetts.

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DYED FIBER DICHROISM

(Continued from Page 98)

The washed samples were then filtered and placed in test tubes.

Mounting the Dyed Fibers on Slides

The water in the dyed samples was removed by displacement with acetone and the acetone was in turn displaced with nitrobenzene. The fibers were then mounted directly in a medium of nitrobenzene and spread over a slide by manual operation with a pair of needles. Nitrobenzene was used as the mounting medium to eliminate most of the scattering of the light by the fiber, since its index of refraction of 1.55 is close to the two indices for cellulose.

SELECTION OF EXPRESSION REPRESENTING DEGREE OF DICHROISM

The logical first step in the selection of a relation between polarized light transmittances of fibers which would express the magnitude of the dichroic effect was a study of the variation of the transmittance of dyed fibers with the angle which the plane of polarization made with the fiber axis. Such a study was made and the data revealed that the maximum transmittance value is never very different from the value obtained when the plane of polarization is perpendicular to the fiber axis and that the minimum value is never very different from the one obtained when the polarization is parallel to the fiber axis. This indicates that a relation between the parallel and perpendicular transmittance values will offer a satisfactory measure of the dichroism.

The question then arose as to whether the parallel and perpendicular transmittance values were representative of the whole angular distribution of transmittances; that is, whether specification of the parallel and perpendicular transmittance values for a given fiber specified the transmittance values for all angles of polarization according to a given law and that all fibers followed this law. To check this point a theoretical expression for the variation of fiber transmittance with angle of polarization was derived so that transmittances for various angles could be calculated and compared with values actually observed. The expression is:

$$T = T_{\parallel} \cos^2\theta + T_{\perp} \sin^2\theta,$$

where θ is the angle between the plane of polarization and the fiber axis, T is the over-all transmittance of the fiber, and $T_{\parallel}$ or $T_{\perp}$ the transmittance of the fiber when the plane of polarization is parallel or perpendicular to it. Using this equation and measured values of $T_{\parallel}$ and $T_{\perp}$, the total transmittance T at various values of θ was calculated for a group of dyed fibers. The agreement between the observed and calculated values is shown in Table I to be very good, and it appears that data on the parallel and perpendicular transmittances are sufficient. Therefore, a relation between these two measurements should furnish a suitable index of the magnitude of the dichroic effect.

TABLE I

Observed and Calculated Values of Fiber Transmittances for Various Angles of Polarization

Fiber	*Angle of Polarization Degrees*	*Calculated Transmittance %*	*Observed Transmittance* %*
1	15	30	31
	30	40	43
	45	55	57
	60	71	73
	75	81	80
2	15	79	80
	45	84	83
	75	88	89
3	15	28	29
	45	56	57
	75	79	80
4	15	65	64
	45	75	75
	75	84	85
5	15	44	45
	45	63	63
	75	80	80

*Note: The observed values are averages of the two readings obtained on each side of the angular distribution.

It next became necessary to decide upon the type of relation to be set up between the principal transmittances. As mentioned before, Preston[7] derived an equation for the degree of dichroism on the basis of Lambert's hypothesis and Beer's law. His derivation was in principle as follows:

If I_0 is the original intensity of the light, I the intensity of the light after undergoing absorption, c the concentration of the dye, d the thickness of the absorbing layer, and k is a constant, then

$$I = I_0 e^{-kcd}, \text{ and}$$
$$\log (I/I_0) = -kcd.$$

Or, if the thickness d is constant,

$$\log (I/I_0) = -Kc$$

But $\log (I/I_0) = -\mu$, where μ is the absorption coefficient; therefore

$$\mu = Kc.$$

Taking the case of a fiber having an effective concentration of $c_{\parallel}$ for particles of dye which absorb light polarized parallel to the axis and $c_{\perp}$ for particles which absorb light polarized perpendicular to the fiber, then if $\mu_{\parallel}$ is the absorption coefficient for parallel polarization and $\mu_{\perp}$ is the absorption coefficient for perpendicular polarization,

$$\mu_{\parallel} = Kc_{\parallel}$$
$$\mu_{\perp} = Kc_{\perp}$$

Dividing one equation by the other, Preston arrives at the following equation for the degree of dichroism:

$$\text{Dichroic constant } (p) = \mu_{\parallel}/\mu_{\perp} = Kc_{\parallel}/Kc_{\perp}$$

Preston made the claim that this constant was independent of the wavelength of the light used in making the transmittance measurements, but the evidence offered in support of this statement does not appear to be conclusive. Therefore, it was decided to test the constancy of the ex-

pression by measuring the parallel and perpendicular transmittances for dyed fibers at several different wave lengths throughout the spectrum and substituting them in Preston's equation, which may be rewritten in the form

$$\text{Dichroic constant} = (p) = \log (I_{o\parallel}/I_{i\parallel}) \log (I_{o\perp}/I_{i\perp})$$

Samples of west coast bleached sulfite pulp were dyed with 0.2% solutions of Du Pont Congo red, Du Pont Methylene blue ZX, and Pontamine violet N. Transmittance measurements were made for several individual fibers from each dyeing at several different wave lengths of light as furnished by the tungsten source in conjunction with the Wratten monochromatic series of filters and a Jena BG-18 filter. The data are presented in Table II.

TABLE II
Effect of Wavelength on the Dichroic Constant of Dyed Fibers

	Effective Wavelength mμ	$\log (I_{o\parallel}/I_{i\parallel})$	$\log (I_{o\perp}/I_{i\perp})$	*Dichroic Constant*
		Congo Red		
1	457	0.214	0.114	1.88
	490	0.203	0.119	1.70
	531	0.190	0.106	1.80
	572	0.108	0.042	2.58
	598	0.065	0.019	3.43
2	457	0.244	0.159	1.54
	490	0.250	0.180	1.39
	531	0.184	0.138	1.33
	572	0.137	0.071	1.93
	598	0.088	0.039	2.25
3	457	0.252	0.147	1.72
	490	0.260	0.163	1.60
	531	0.212	0.140	1.51
	572	0.159	0.074	2.15
	598	0.125	0.040	3.12
		Methylene Blue		
1	490	0.086	0.051	1.68
	531	0.103	0.060	1.72
	572	0.135	0.093	1.45
	598	0.190	0.145	1.31
	630	0.172	0.123	1.40
2	490	0.137	0.048	2.86
	531	0.156	0.052	3.00
	572	0.218	0.092	2.37
	598	0.274	0.149	1.84
	630	0.255	0.106	2.40
3	490	0.108	0.055	1.97
	531	0.111	0.055	2.02
	572	0.169	0.103	1.65
	598	0.210	0.136	1.55
	630	0.184	0.125	1.47
		Pontamine Violet		
1	457	0.148	0.077	1.92
	490	0.191	0.100	1.91
	531	0.182	0.115	1.58
	572	0.189	0.080	2.36
	598	0.136	0.066	2.06
2	457	0.146	0.108	1.35
	490	0.190	0.154	1.23
	531	0.176	0.149	1.18
	572	0.149	0.118	1.26
	598	0.130	0.087	1.50
3	457	0.180	0.132	1.36
	490	0.215	0.160	1.34
	531	0.176	0.167	1.06
	572	0.151	0.131	1.15
	598	0.133	0.093	1.43
4	457	0.195	0.139	1.40
	490	0.219	0.179	1.23
	531	0.182	0.160	1.14
	572	0.151	0.131	1.15
	598	0.157	0.092	1.71

*Note: The filters used were Wratten Nos. 49, 75, 74, 73, 72, and 71A, which furnished light and effective wavelengths 457, 490, 531, 572, 598 and 630 mμ, respectively.

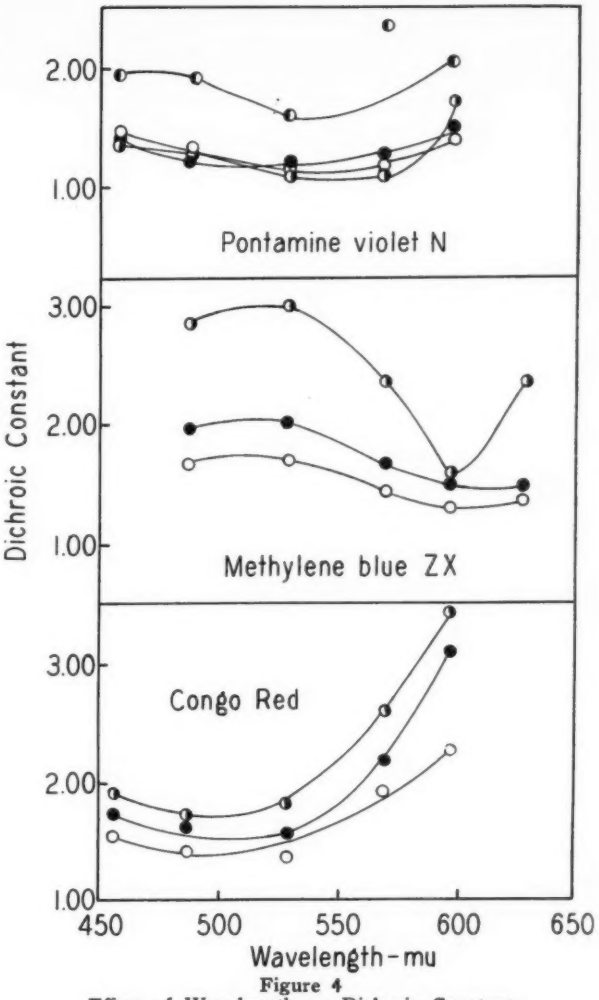

Figure 4
Effect of Wavelength on Dichroic Constant

It is obvious from the data that, for the dyed fibers measured, the dichroic constant is by no means independent of the wavelength. Because Preston did most of his work on dyed cellophane, it was decided to repeat the study using cellophane, which was dyed for ten minutes at 70° C. in a one per cent solution of Du Pont Congo red. The washed and dried sheet was placed before the photocell on the instrument and the principal transmittances observed for a number of wavelengths. The results are tabulated below. The trend is the same as for the dyed fibers.

TABLE III
Effect of Wavelength on the Dichroic Constant of Dyed Cellophane

Filter	*Effective Wavelength*	$\log (I_{o\parallel}'/I_{i\parallel})$	$\log (I_{o\perp}/I_{i\perp})$	*Dichroic Constant*
75	490	0.797	0.552	1.44
74	531	0.759	0.478	1.59
73	572	0.259	0.130	1.99
72	598	0.052	0.029	1.79

The data from Table II on the fiber transmittances are plotted in Figure 4. The similarity in shape of the curves for the different fibers indicates that the variation of the constant with wavelength is not just a coincidence for the

few fibers on which measurements were made.

A hint as to the discrepancy in Preston's work on the effect of wavelength is furnished by a consideration of his derivation of an expression indicating the percentage orientation of dyestuff particles in terms of the dichroic constant. His derivation infers that the following relations are true:

$$\mu_{\parallel} = \mu \cos^2 \gamma$$
$$\mu_{\perp} = \sin^2 \gamma \cos^2\theta$$
$$\mu'_{\perp} = \mu \sin^2 \gamma \sin^2\theta$$

In other words, the absorption cofficients of a dyed fiber for light polarized in the axial and radial directions, are taken to be the above written functions of the absorption coefficient, μ, of the dye particle oriented at some angle to the fiber. But this assumes that the individual dye particle itself absorbs light polarized only in the direction of its own axis. If this were not the case, the above expressions would have to be written as shown below to account for the absorption by the particle of light vibrating in its own radial directions:

$$\mu_{\parallel} \text{ fiber} = \mu_{\parallel} \text{ particle} \cos^2\gamma + \mu_{\perp} \text{ particle} \sin^2\gamma \cos^2\theta + \mu'_{\perp} \text{ particle} \sin^2\gamma \sin^2\theta$$
$$\mu_{\perp} \text{ fiber} = \mu_{\perp} \text{ particle} \cos^2\gamma + \mu_{\parallel} \text{ particle} \sin^2\gamma \cos^2\theta + \mu'_{\perp} \text{ particle} \sin^2\gamma \sin^2\theta$$
$$\mu'_{\perp} \text{ fiber} = \mu'_{\perp} \text{ particle} \cos^2\gamma + \mu_{\perp} \text{ particle} \sin^2\gamma \cos^2\theta + \mu_{\parallel} \text{ particle} \sin^2\gamma \sin^2\theta$$

It is readily seen that, if $\mu_{\perp}$ particle and $\mu'_{\perp}$ particle are zero, which would be the case if the particle absorbed only the light vibrating in its own axis, the second set of equations become equal to the first set.

Preston offered no proof that a dye particle has only one axis of light absorption and, hence, derivation of the orientation expressions may be questioned. The assumption that a dye particle has more than one axis of light absorption makes possible an explanation for the observed variation of the dichroic constant with wavelength. If the particle had only one axis of light absorption, the ratio of percentages of light absorbed by the particle for any two angles of polarization would depend only on the angles of polarization and not on the absorption coefficient. Therefore, the change in the absorption coefficient, which would be occasioned by a change in the wavelength of the incident light, would not affect the ratio of percentages. But if the particle had two or more axes of light absorption, the relative values of the absorption coefficients corresponding to these axes might very well change materially with wavelength. In that event, the ratio of percentages of light absorbed for any two angles of polarization would depend both on the angles of polarization and the wavelength of light used. Hence, the dichroic constant, which is a ratio of absorption coefficients or fractions of light absorbed for two different angles of polarization, is observed to change with wavelength.

Although the dichroic constant is not independent of wavelength, it is a good index of the degree of dichroism for any given wavelength. It is fairly constant with changes in depth of dyeing and very sensitive to small changes in the magnitude of the dichroic effect. Therefore, it will be used to express the dichroism of dyed pulps which are to be compared in the succeeding work.

FACTORS INFLUENCING ACCURACY

Before presentation of the data on the factors which affect the degree of dichroism, consideration should be given to the accuracy with which comparisons of the relative dichroism of two different samples of dyed pulp can be made.

Because of the large variation in dichroic effect from fiber to fiber within a sample of pulp, it was necessary to average the dichroic constants for a number of fibers within that sample. Experiments revealed that a 40-fiber average could be determined with sufficient accuracy. All except pulps which had been beaten were observed to yield 40-fiber averages which had probable errors in the neighborhood of 2 to 3 per cent, which was considered satisfactory. Even for the beaten fibers the 40-fiber average was considered sufficient, because the extremely large changes in dichroism occasioned by the beating obviated the necessity for very accurate measurement.

Another factor which had to be considered in the accuracy of the measurement of the dichroism of dyed fibers was the dichroism of the undyed fiber itself. Undyed fibers have been found to possess intrinsic dichroism because of their oriented structure. However, the transmittances of undyed fibers at all angles of polarization were found to be in the neighborhood of 98 to 99 per cent. Since, in general, the transmittances of the dyed fibers were between 20 and 90 per cent, the effect of light absorption by the fiber itself can be considered negligible.

As mentioned before, the dichroic constant was found to be rather independent of the depth of dyeing. However, in some cases the dichroism was observed to change as the dyeing became deeper, generally toward a larger value. Since it was impossible to dye all pulps to exactly the same depth two different depths were used, so that interpolated values of the dichroic constant for a transmittance or dye weight common to the pulps being compared could be obtained. However, because the variations with depth were never more than two or three times the range of accuracy of measurement of the dichroic constant, interpolation along a straight line between the values obtained for the two different depths of dyeing was considered sufficiently accurate. In the subsequent work interpolations of this kind were made.

PRESENTATION OF DATA AND DISCUSSION

The instrument and techniques described in the foregoing sections were applied to a study of the pulp and dyeing variables which might affect the orientation of dyestuffs on fibers. Specifically, investigations were carried out on the effect of the following factors: the presence of lignin in pulp, fractionation of the pulp, swelling with chemical agents, beating, salt concentration in the dye bath, dye concentration in the dye bath, and dye bath temperature.

Effect of the Presence of Lignin

Qualitative observation of bleached and unbleached pulps dyed with Congo red and Methylene blue revealed that, in

the case of both dyes, the dichroic effect was smaller in the presence of lignin. In the case of the pulps dyed with Methylene blue, this effect was very noticeable in that the unbleached pulp exhibited almost no dichroism, whereas the bleached pulp was found to be quite dichroic. For the Congo red dyeing, the difference in the bleached and unbleached pulps was plainly noticeable but not nearly as large. Evidently this is because Methylene blue (being a basic dyestuff) is absorbed strongly on the lignin present in the unbleached pulps. Because the lignin does not possess an oriented structure, very little dichroism is evident. Apparently Congo red (a direct dyestuff) is also adsorbed on the oriented lignin but to a more limited extent, so that the amount of unoriented dye present is not sufficient to mask the dichroism of the dye particles adsorbed on the cellulose part of the fiber structure.

The qualitative observation of the effect of lignin was checked by a quantitative experiment. Two series of pulps were used, the first consisting of three samples of unbleached kraft cooked to various lignin contents and the second of pulps bleached to various lignin contents by subjecting the unbleached pulp containing the most lignin to hypochlorite bleaching of increasing intensity. These samples were dyed according to the standard method using a dye bath containing 10 grams of Du Pont Congo red and 30 grams of sodium sulfate in 1500 cc. of water at a temperature of 100° C. The data on the dyed samples are given in Table IV.

TABLE IV
Effect of the Presence of Lignin on the Dichroic Constant

Pulp Series	Lignin Content, %	Average Transmittance, %	Dichroic Constant	Dichroic Constant Interpolated to Transmittance of 53.0%
Bleaching Series	0	61.0	1.79	
		45.5	1.72	1.75
	2.31	70.6	1.70	
		45.5	1.60	1.63
	4.23	56.9	1.57	
		39.0	1.57	1.57
Cooking Series	2.39	73.0	1.57	
		47.4	1.69	1.66
	3.63	73.9	1.52	
		49.2	1.61	1.60
	5.93	64.0	1.44	
		51.2	1.60	1.58

The average transmittance figures in the above table represent the average of the parallel and perpendicular transmittances for each pulp.

The data show that the presence of lignin decreases the magnitude of the dichroism. They also reveal that this effect is independent of the method by which the lignin is removed—i.e., whether by cooking or by bleaching. The latter fact indicates that the adsorption of direct dyestuff is probably not controlled by the formation of polar groups during cooking or bleaching.

Effect of Fractionation

It was reported by Ritter[16] that the medullary ray cells in wood pulp possess a structure oriented perpendicular to their axes in contrast to the ordinary fibers. It had also been observed in the present work that occasionally (1 to 2 per cent) fibers with reverse orientation were encountered. Therefore, it seemed possible that the degree of dichroism might be affected materially by the average fiber lengths for a given pulp. An investigation was carried out to see if this was the case. A 10-gram sample of bleached sulfite pulp was fractionated for 15 minutes in Bauer-McNett classifier. Fractions caught on the 20, 35, and 65-mesh screens were then dyed with a solution of 10 grams of Pontamine Violet N in 1500 cc. of water. The results are tabulated in Table V. It should be mentioned, however, that the usual method of correcting for any differences in depth of dyeing was not possible in the case of the fractionated pulps because the average fiber thickness undoubtedly differs for the different fractions—i.e., two fractions can not be compared as to depth of dyeing on the basis of their average transmittances. Therefore, the data are presented with this reservation in mind.

TABLE V
Effect of Fractionation of the Pulp on the Dichroic Constant

Fiber Fraction	Dichroic Constant	Average Dichroic Constant
20-mesh	3.32	
	2.53	2.93
35-mesh	2.56	
	2.38	2.47
65-mesh	2.58	
	2.32	2.45

The trend appears to be in the expected direction. In other words, the dichroism of the smaller fibers appears to be smaller. However, it is realized that five of the six values shown are almost within the limits of accuracy of measurement, so that the trend is by no means certain.

Effect of Swelling by Chemical Agents

It is well known that fibers which have been swollen by various chemical agents exhibit a greatly enhanced affinity for dyestuffs. It was reasoned that the increased affinity might be caused by an opening up of the structure to make new bonding groups available to the dye. If this were the case, it was possible that the adsorbing strength of these bonds might be the result of an increased ability of the dyestuff particles to penetrate the opened-up structure and line themselves in the direction in which they exhibit their maximum bonding strength. This might very well cause an increase in the dichroic constant of a swollen pulp when it was dyed. Therefore, an experiment was performed with the object of discovering if this were true.

Three samples of bleached sulfite were treated with swelling agents in the following manner: One-half gram samples of the pulp were treated for one hour at 20° C. with 8 per cent and 17 per cent sodium hydroxide and for 10 minutes at room temperature with a solution of cuprammonium hydroxide containing 3.75 grams of copper and 52.5 grams of ammonia per liter. The pulps were then washed with water and dilute acetic acid. These samples

were dyed in a solution of 20 grams of Du Pont Fast orange EVL in 1500 cc. of water, maintaining the temperature at 100° C. The dichroic constants were measured in the standard manner. The values obtained are shown in Table VI.

It is readily seen that the results are exactly the opposite of the expected ones. The degree of dichroism shows a decided decrease for the swollen pulps. Two possible explanations suggest themselves. One is that the oriented structure of the cellulose is broken down by the action of the chemical agents to the point where the dichroism is decreased. The other is that the nature of the exposed adsorbing surface is changed, so that a new kind of bond is formed which does not orient the dye particles.

TABLE VI
Effect of Chemical Swelling of Pulp on the Dichroic Constant

Swelling Agent	Average Transmittance, %	Dichroic Constant	Dichroic Constant Interpolated to Transmittance of 72.0%
None	78.5	2.28	
	76.5	2.33	2.41
8% NaOH	74.5	2.09	
	66.5	2.28	2.15
17% NaOH	66.5	1.91	
	80.8	1.95	1.92
Cuprammonium Hydroxide	72.0	2.22	
	60.8	2.51	2.22

Of the two explanations mentioned above, it seems that the second, involving change of the type of exposed adsorbing surface, is best borne out by the data. It is known that, at the mercerizing strength of 17 per cent sodium hydroxide, a change in the crystalline structure of the cellulose occurs, as revealed by x-ray diagrams. This change does not occur at concentrations below 10 or 11 per cent. Therefore, since the samples swollen with both the 8 per cent and the 17 per cent exhibit a decrease in dichroism, it is probable that it is not caused by the change in crystalline structure.

Effect of Beating

Reasoning along the above lines led to the thought that the increased adsorption of dyestuff by beaten fibers might be reflected in an increased dichroic constant.

Three different pulps (a bleached spruce sulfite, a bleached western hemlock sulfite, and a bleached Douglas fir sulfite) were beaten to various freeness values in a laboratory Valley beater. The dichroic constants of the dyed fibers are given in Table VII.

The effect of beating is obviously the largest effect noted thus far. In view of this fact, it was considered desirable to examine the change in dichroic constant throughout an entire beating period and to correlate it with other properties of beaten pulp, especially those associated with hydration, such as freeness and bursting strength. Accordingly, a beater run was made on the western hemlock bleached sulfite. Samples were taken at each beating interval and dyed at 90° C. with a solution of 30 grams of Fast orange EVL in 1500 cc. of water. The dichroic constants are

TABLE VII
Effect of Beating of Pulp on the Dichroic Constant

Pulp	Dyestuff	Average Transmittance %	Dichroic Constant	Interpolated Dichroic Constant
Western hemlock	Fast orange EVL	83.2	2.06	
Unbeaten	20 g. in	69.0	2.30	2.30
Beaten to	1500 cc.	73.4	4.75	
540 cc. S.R.	H_2O at 100° C.	64.4	5.72	5.21
Spruce	Fast orange EVL	79.0	2.38	
Unbeaten	30 g. in	80.0	2.25	2.47
Beaten to	1500 cc.	77.0	3.97	
650 cc. S.R.	H_2O at 90° C.	75.3	4.78	3.97
Western hemlock	Pontamine			
Unbeaten	violet N	58.0	3.06	
Beaten to	10 g. in	65.4	3.13	3.06
390 cc. S.R.	1500 cc.	66.2	4.73	
	H_2O at 90° C.	55.0	4.23	4.37
Douglas fir	Congo red	50.0	2.22	
Unbeaten	10 g. in	55.0	3.06	2.89
Beaten to	1500 cc.	47.8	3.50	
450 cc. S.R.	H_2O at 90° C.	54.5	5.25	5.10

TABLE VIII
Change in Dichroic Constant with Freeness and Bursting Strength

Freeness cc. S.R.	Burst Factor	Average Transmittance %	Dichroic Constant	Dichroic Constant Interpolated to Transmittance of 70.0%
865	10.8	74.5	2.90	
		65.0	3.15	3.02
830	67	69.6	4.71	
		66.5	4.20	4.78
690	94	74.0	5.10	
		68.5	5.35	5.28
530	102	72.5	7.00	
		70.0	6.55	6.55
390	99	74.5	7.10	
		69.5	7.86	7.78

tabulated in Table VIII and plotted in Figure 5.

The tremendous increase in dye orientation for beaten pulps revealed by the data is at first glance surprising because, although the beating presumably opens up the fiber, it also partially destroys it and it might be concluded that the destruction of the oriented structure could occur during beating. However, if consideration is given to facts concerning the structure of pulp fibers, a logical explanation can be offered for the effect observed. The general concept of the structure of a fiber is that it is composed of an inner portion oriented in the direction of the fiber axis and an outer skin oriented more in the tangential direction. It is possible that, as the beating progresses, this skin is loosened up or removed so that the dyestuff can penetrate to the inner and more axially oriented portion of the fiber. Evidently the changes in adsorbing surface of the fiber which are responsible for increased dichroism are not very closely related to the hydration effects which cause the development of bursting strength and a decrease in the freeness.

Effect of Salt Concentration

Theoretically the addition of a salt (such as sodium sulfate) in very high concentration to a dyebath could have one of two effects on the orientation of dye particles on fibers. On one hand, it might serve to salt out or

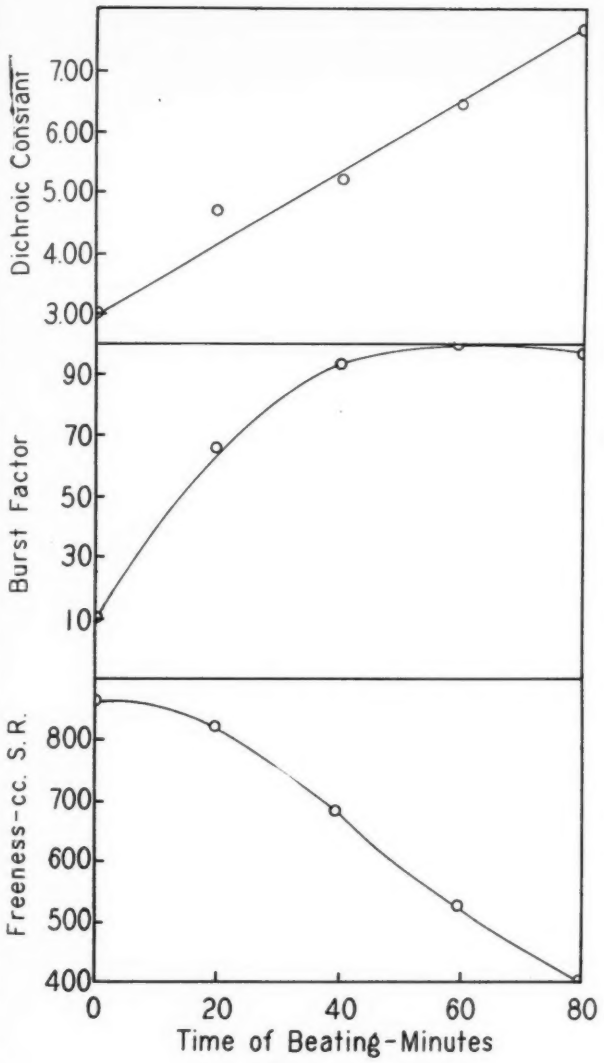

Figure 5
Correlation of Dichroic Constant with Freeness and Bursting Strength

precipitate the dyestuff on the fiber, in which case it is probable that a decrease in dichroism would be observed because of a random precipitation of the dye particles. On the other hand, as Matthews[17] points out, it might act as an inhibitor to the speed of the dyeing and allow the dye to be adsorbed more slowly, so that it might orient itself more perfectly. The use of sodium sulfate is a common device employed in dyeing to obtain more level colors through retardation of the rate at which the dye goes into the fiber.

To study the effect of this factor, samples of bleached sulfite were dyed at 80°C. in a solution of 10 grams of Pontamine Violet N in 1500 cc. of water. The dyeings were carried out first with no salt present and then with the successive additions of enough sodium sulfate to bring the salt concentrations to 1.3 per cent and 4 per cent. The dichroic constants for the dyed pulps are shown in Table IX.

TABLE IX
Effect of Salt Concentration in Dye Bath on Dichroic Constant

Salt Concentration %	Average Transmittance %	Dichroic Constant	Dichroic constant Interpolated to Transmittance of 64.0%
0	73.2	1.65	
	53.4	2.00	1.82
1.3	68.0	1.62	
	59.6	1.74	1.68
4.0	63.7	2.19	
	77.2	2.08	2.19

The data appear to corroborate the second of the theories proposed above—namely, that the sodium sulfate acts as a retarder and permits the dyestuff to become oriented through slow adsorption on the fiber.

Effect of Dye Concentration and Temperature

It was expected that the concentration of dye in the dye bath for strong dye solutions would exert an effect on particle size which might be reflected in the degree of orientation of the dyestuff on the fiber. In concentrated solutions, where the particles of dye were large, it was thought the dye would have difficulty in penetrating the fiber and that the orientation would therefore be decreased.

Samples of bleached sulfite were dyed in solutions of 5, 10, and 20 grams of Pontamine violet N in 1500 cc. of water. The temperature was maintained at 80° C. The data are shown in Table X.

TABLE X
Effect of Concentration of Dye in Bath on Dichroic Constant

Dye Concentration g./1500 cc.	Average Transmittance %	Dichroic Constant	Dichroic Constant Interpolated to Transmittance of 73.0%
5	72.0	2.47	
	69.9	2.72	2.35
10	74.0	2.72	
	66.0	2.57	2.70
20	75.0	2.48	
	73.0	2.82	2.82

The effect is seen to be opposite to the expected effect, but the data appear to be erratic.

With regard to the effect of dyeing temperature, the dichroism might well be increased by using hot solutions of dyestuffs because better penetration of the dyestuff into the oriented inner portions of the fiber should be obtained. To study this factor two samples of bleached sulfite were dyed at 25° and 90° C. in the same solution of 10 grams of Pontamine violet N in 1500 cc. of water.

TABLE XI
Effect of Temperature of Dye Bath on the Dichroic Constant

Temperature ° C.	Average Transmittance %	Dichroic Constant	Dichroic Constant Interpolated to Transmittance of 70.0%
25	76.5	2.55	
	78.5	2.78	2.74
90	79.0	2.65	
	69.5	2.82	2.81

The dyeing temperature appears to have no appreciable effect on the orientation.

SUMMARY AND CONCLUSIONS

A photoelectric instrument has been designed and constructed for the measurement of the transmittances of dyed pulp fibers for light polarized at any desired angle with the fiber axis.

The validity of choosing a relation between the transmittances obtained for the two cases where the plane of polarization is parallel and perpendicular to the fiber axis as a means of expressing the degree of dichroism of the fiber was proved. The relation selected was the ratio of absorption coefficients for parallel and perpendicular polarization for a given wavelength and depth of dyeing.

Using the above mentioned instrument and relation, a study was made of the factors affecting dyed fiber dichroism, a measure of the extent to which a dyestuff is oriented on pulp fibers. The following results were obtained:

1. The dichroism increased with decreasing amounts of lignin in pulp.
2. Short-fibered fractions of pulp exhibited less dichroism than the long-fibered fractions.
3. The dichroism decreased when pulps were treated with chemical swelling agents.
4. A very marked increase in the dichroism was observed as a pulp was beaten.
5. The dichroism increased as a salt was added to the dyebath.
6. The dichroism increased as the concentration of dye in the dye bath was increased.
7. Variation of the temperature of the dye bath over a given range had no effect on the dichroism.

An attempt was made to explain the observed effects and show their significance.

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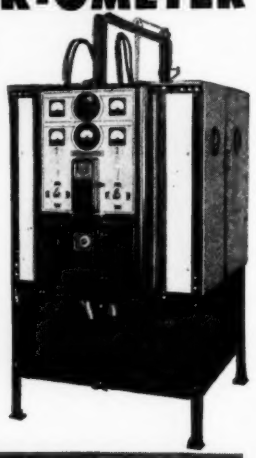

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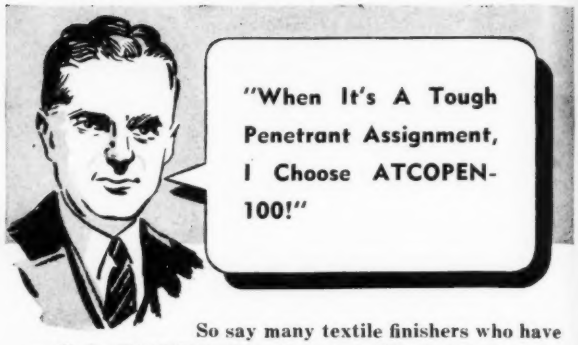

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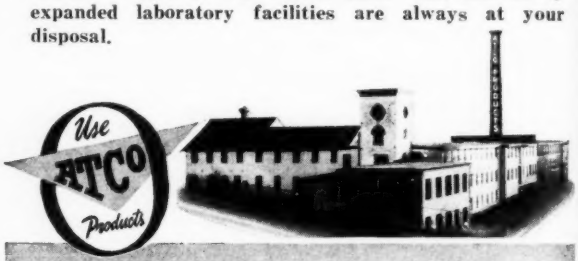

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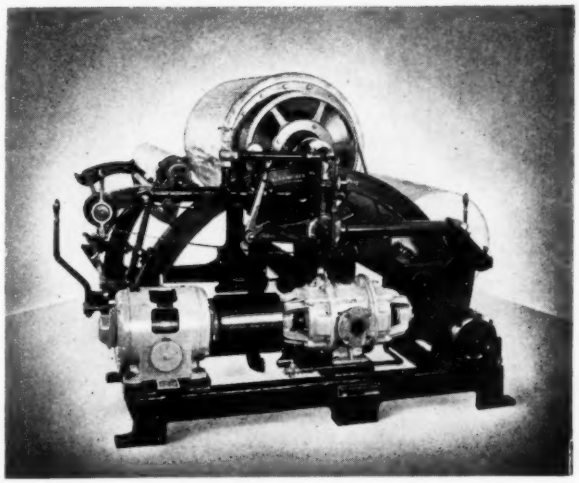

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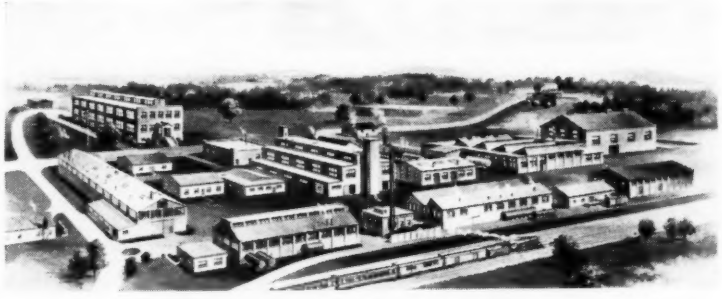

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